1988

Alternative Sources of Large Seasonal Ground-water Supplies in the Headwaters of the Susquehanna River Basin, New York

Allan D. Randall
USGS

Deborah S. Snavely
USGS

Thomas J. Holecek
USGS

Roger M. Waller
USGS

ALTERNATIVE SOURCES OF LARGE SEASONAL GROUND-WATER SUPPLIES IN THE HEADWATERS OF THE SUSQUEHANNA RIVER BASIN, NEW YORK

By Allan D. Randall, Deborah S. Snavely,
Thomas J. Holecek, and Roger M. Waller

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 85-4127

Prepared in cooperation with

SUSQUEHANNA RIVER BASIN COMMISSION

Albany, New York

1988

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

U.S. Geological Survey
P.O. Box 1669
Albany, New York 12201
(518) 472-3107

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Bldg. 41
Box 25425
Denver, Colorado 80225
(303) 236-7476

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (continued)

TABLES

CONVERSION FACTORS AND ABBREVIATIONS

The following factors may be used to convert units of measurement in this report to metric (International System) units.

Multiply	by	To obtain
inch (in.)	2.540	centimeter (cm)
foot (ft)	0.3048	meter (m)
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallon per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.59	square kilometer (km^2)
cubic foot per second (ft^3/s)	28.32	liter per second (L/s)
	0.02832	cubic meter per second (m^3/s)
acre	0.40	hectare
feet squared per day (ft^2/d)	0.0929	meters squared per day (m^2/d)

Alternative Sources of Large Seasonal Ground-Water Supplies in the Headwaters of the Susquehanna River Basin, New York

By Allan D. Randall, Deborah S. Snavely,
Thomas J. Holecek, and Roger M. Waller

Abstract

The bedrock ridges that form the northern divide of the Susquehanna River basin have been breached by glacial erosion in at least 29 localities. The resulting broad valleys, which bisect the drainage divide, are called "through valleys." Through valleys resemble major river valleys in width and in being underlain by a few hundred feet of glacial deposits, including water-yielding sands and gravels. However, they differ from major river valleys in that they are drained only by small headwater streams. Therefore, large temporary ground-water withdrawals are feasible, and such withdrawals during summer or fall would not greatly deplete naturally low streamflow at points downstream because the lowered water table could not induce river water that originated elsewhere to seep into the aquifer. Seasonal withdrawals from through valleys would be limited by three constraints: maximum acceptable lowering of the water table; hydraulic properties of the aquifer, which control well yield and the extent to which ground-water discharge to headwater streams would be reduced; and the degree to which recharge from winter and spring runoff would exceed normal rates as long as the water table remained below normal.

A typical through valley was selected to demonstrate quantitatively the behavior and potential seasonal yield of such systems. Infiltration of runoff from the uplands constituted 60 percent of recharge to the valley fill. A digital model, calibrated to observed water-level changes and estimated underflow, indicated that withdrawal of 10.8 million gallons per day for 2 months in summer near the divide would lower the water table as much as 33 feet near production wells and would cause the point at which streamflow begins along the valley axis to move 1,900 feet downvalley. The estimated increase in recharge due to the lowered water table would return the water table and the point of beginning streamflow to prepumping conditions by late spring, thus allowing the same seasonal withdrawal to be repeated each year. Pumpage of 17 million gallons per day or more for 2 months would be feasible if reductions in water levels and streamflow beyond the following spring were not of concern.

The potential seasonal withdrawal from through valleys should be directly proportional to the area and saturated thickness of the sand and gravel aquifer, and to some fraction of the discharge or area of bordering hillsides and upland basins that drain to or across the aquifer. Eighteen valleys were evaluated qualitatively as to their potential for seasonal use; nearly all of these are between 0.8 and 8 square miles in area. Ten are bordered by tributary upland areas that are at least twice the valley area, and nine are underlain by surficial sand and gravel whose saturated thickness is more than 40 feet. The five easternmost and four westernmost valleys generally contain only 20 to 30 feet of saturated outwash overlying extensive fine-grained lacustrine deposits. Several valleys contain extensive wetlands, recreational lakes, and(or) other water uses that could be affected by large seasonal lowering of the water table.

INTRODUCTION

Streamflow in the Susquehanna River basin of New York is used for many purposes, including water supply, cooling, wastewater dilution, recreation, and wildlife habitat. Throughout the basin, however, the flow of streams is much smaller in late summer than in early spring. For example, median flows in September are about 8 percent of median flows in April, and weekly flows as low as 2 percent of median April flows occur once in 10 years on the average. This variability in flow may interfere with the multiple demands on streamflow because not all demands can always be met during times of lowest flow. Three strategies that have been proposed to compensate for seasonally low streamflow are (1) to construct surface reservoirs from which water may be diverted during periods of low flow for local needs or released to augment natural flow, (2) to provide stringent wastewater treatment to ensure acceptable river-water quality when flow is low, and (3) to use ground water as an alternative source to supplement or substitute for temporarily inadequate river flow.

This report describes several concepts and principles that govern the large-scale use of ground water in the Susquehanna River basin as an alternative to surface water during periods of low flow. It also gives qualitative appraisals of 18 localities that may be suitable for large seasonal ground-water withdrawals and presents a quantitative analysis of the potential effects of seasonal withdrawals in one such locality, based on results of a digital model calibrated to observed water-level changes and estimated underflow. It was prepared by the U.S. Geological Survey in cooperation with the Susquehanna River Basin Commission as one component of a basinwide study that was administered by the Commission, financed on a cost-sharing basis with Federal funds through the Water Resources Council, and intended to provide information useful in future management of ground water (Bielo, 1979). Report preparation was also supported by the Regional Aquifer Systems Analysis program of the U.S. Geological Survey.

USE OF GROUND WATER AS AN ALTERNATIVE TO SURFACE WATER DURING PERIODS OF LOW STREAMFLOW: SOME IMPORTANT CONSIDERATIONS

Interdependence Between Typical Aquifers and Streams

If the reason for proposing ground-water withdrawals is to obtain water without further depleting streamflow when it is already low, the ground-water source obviously should be nearly independent of streamflow. Such independence is rare in the Susquehanna River basin, however. The only highly productive aquifers are sand-and-gravel deposits within the broad valleys, and water can readily move back and forth between these aquifers and the streams that cross them, as evidenced by various observations. For example, permeable sand and gravel immediately underlies the valley floors and is generally at least 10 feet thick (MacNish and Randall, 1982, pl. 1). Nearly all stream channels are floored with gravel. Water levels in wells that tap near-surface sand or gravel are commonly close to river level (Randall, 1972), which implies that ground water drains easily from these surficial aquifers into the rivers. Seepage from surficial sand and gravel aquifers to streams is the principal source of streamflow during rainless periods (Ku and others, 1975). Infiltration of surface water from streams to large-capacity wells has been demonstrated in several localities from records of water temperature in wells (Randall, 1970; 1977, p. 62; 1981, p. 168; written commun., 1968).

The ready interchange between valley aquifer and stream enables large withdrawals from wells to deplete streamflow at a rate that approaches the rate of pumping. The pumped well captures ground water that would otherwise seep into the stream and, by lowering the water table below stream level, it induces water to seep from the stream into the aquifer. MacNish and others (1969) estimated potential induced infiltration in three valley reaches to be at least 12 times greater than the amount of recharge available from local sources. Paul Seaber (U.S. Geological Survey, written commun., 1967) analyzed the interaction between river and aquifer in several typical valleys in the Susquehanna River basin. He estimated that, after 90 days of pumping from wells near the sides of valleys 4,000 to 5,000 feet wide, 36 to 98 percent of the water being pumped would represent depletion of river flow. (The remaining 64 to 2 percent would represent depletion of storage in the aquifer as water levels continued to decline.) The range in these percentages was a function of the river's position near one side or the center of the valley, hence of how far the wells could be placed from the river. The rate of river depletion would be greater after longer pumping times and in narrow valleys and is also a function of aquifer properties. Under such conditions, large-scale pumping from wells amounts to indirect diversion of streamflow (Susquehanna River Basin Coordinating Committee, 1971, Appendix 8, p. V11-14).

Aquifers That May Constitute Independent Water Reservoirs

Although ground water in the valleys of the Susquehanna River basin cannot generally be treated as a resource separate from surface water, four types of productive aquifers are relatively isolated from large streams and therefore should be able to sustain large temporary withdrawals without causing immediate depletion of streamflow. They include:

1. Buried aquifers (fig. 1A), which consist of thick sand and gravel overlain nearly everywhere by extensive deposits of lacustrine silt and clay.

2. Valley-side aquifers (fig. 1B), which are thick surficial aquifers along one side of a valley, bordered along the valley axis by younger lacustrine deposits that are capped by a sand or gravel layer too thin to transmit much water.

3. Separated valleys (fig. 1C), which are broad valleys floored with stratified drift, that abut large streams at one or both ends but elsewhere are separated from the river by a ridge of till or bedrock.

4. Through valleys (fig. 1D), which are broad valleys floored with stratified drift, cut through bedrock ridges on the basin divide and drained only by tiny headwater streams.

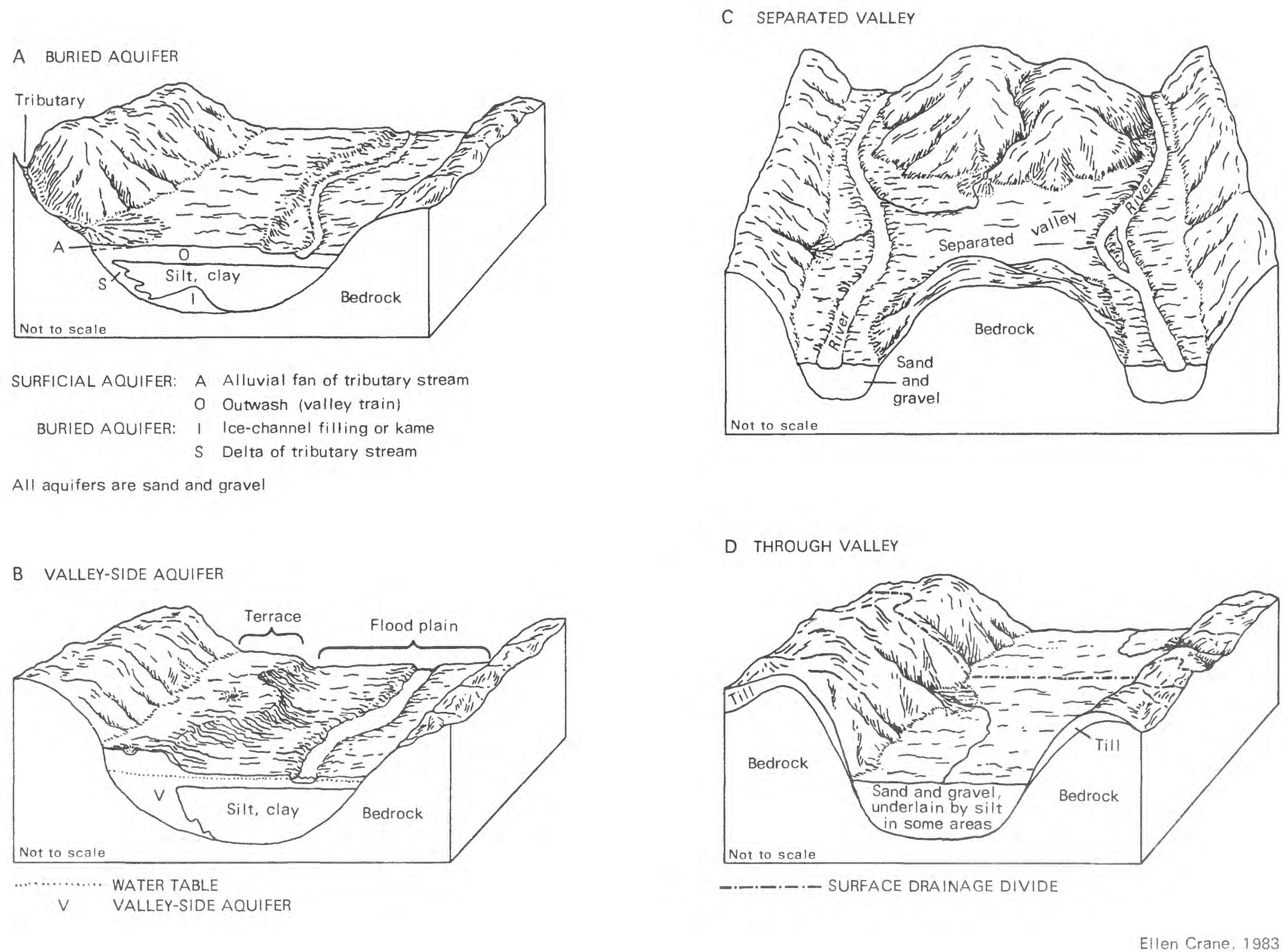


Figure 1.--Types of aquifers in which the potential for induced infiltration of surface water is small.

Large withdrawals from an aquifer of any of these four types would cause severe depletion of ground water stored in the aquifer. The lowered water levels would eventually force a reduction in pumping rate and(or) cause depletion of streamflow. Nevertheless, these types of aquifers could be treated as a special class of water resource, one that is comparable to surface reservoirs on streams in that they are nearly independent of natural dry-weather streamflow and thus would be especially suitable sources of water to meet demands that arise each year in the low-flow season. Examples of such demands are (a) onsite seasonal uses such as irrigation, commercial produce canning, and air conditioning; (b) streamflow augmentation, whereby ground water is pumped into stream channels when natural flow at points downstream is critically low; (c) supplemental or temporary municipal or industrial water supplies, which would be idle most of the time but could be pumped during dry periods if the normal water source declined in yield, became too warm, or depleted streamflow needed downstream.

Of the four types of independent aquifers (fig. 1), buried aquifers and valley-side aquifers may be the most prevalent in the Susquehanna River basin. MacNish and Randall (1982, pl. 1) infer buried aquifers in several localities, and some of their surficial aquifers may qualify as valley-side aquifers. Neither type can be easily evaluated, however. Much more subsurface information would be required than was available in the early 1980's to accurately delineate such aquifers, estimate their yields and confirm their isolation from streams. Aquifers of the third type, separated valleys, are easily identified (fig. 2). Most have been individually described and their ground-water potential evaluated (Randall, 1977; Cosner and Harsh, 1978; Reynolds, 1987; Reynolds and Brown, 1984; VanAlstyne, 1982).

Through valleys, the fourth type of independent aquifer, are the subject of this report. Their characteristics and potential seasonal use are described below in general terms. Then, one valley is evaluated in detail as a quantitative example of the effects of seasonal development. Later, the potential for seasonal ground-water supplies in each of 18 through valleys is described to the extent that hydrologic data permit.

USE OF AQUIFERS AS RESERVOIRS IN THROUGH VALLEYS IN THE SUSQUEHANNA RIVER BASIN HEADWATERS

Form and Origin of Through Valleys

Drainage divides normally follow the crests of ridges, and headwater streams descend steep slopes on each side of the divide. However, in at least 29 localities along the northern perimeter of the Susquehanna River basin (fig. 2), the drainage divide crosses broad valleys whose flat floors slope gently south from the divide into the Susquehanna River basin, and less gently north from the divide into adjacent basins. These anomalous features are termed "through valleys" in the geologic literature. They developed as a result of continental glaciation, probably in the manner described by von Engeln (1961, p. 60-62) and Coates (1966a). Every time glaciers approached central New York, they blocked the north-draining valleys, which therefore became lakes and spilled southward into the Susquehanna basin across saddles in the bedrock divide. As meltwater poured across the saddles and down their south slopes, it cut gorges that breached the divide. Erosion by ice widened

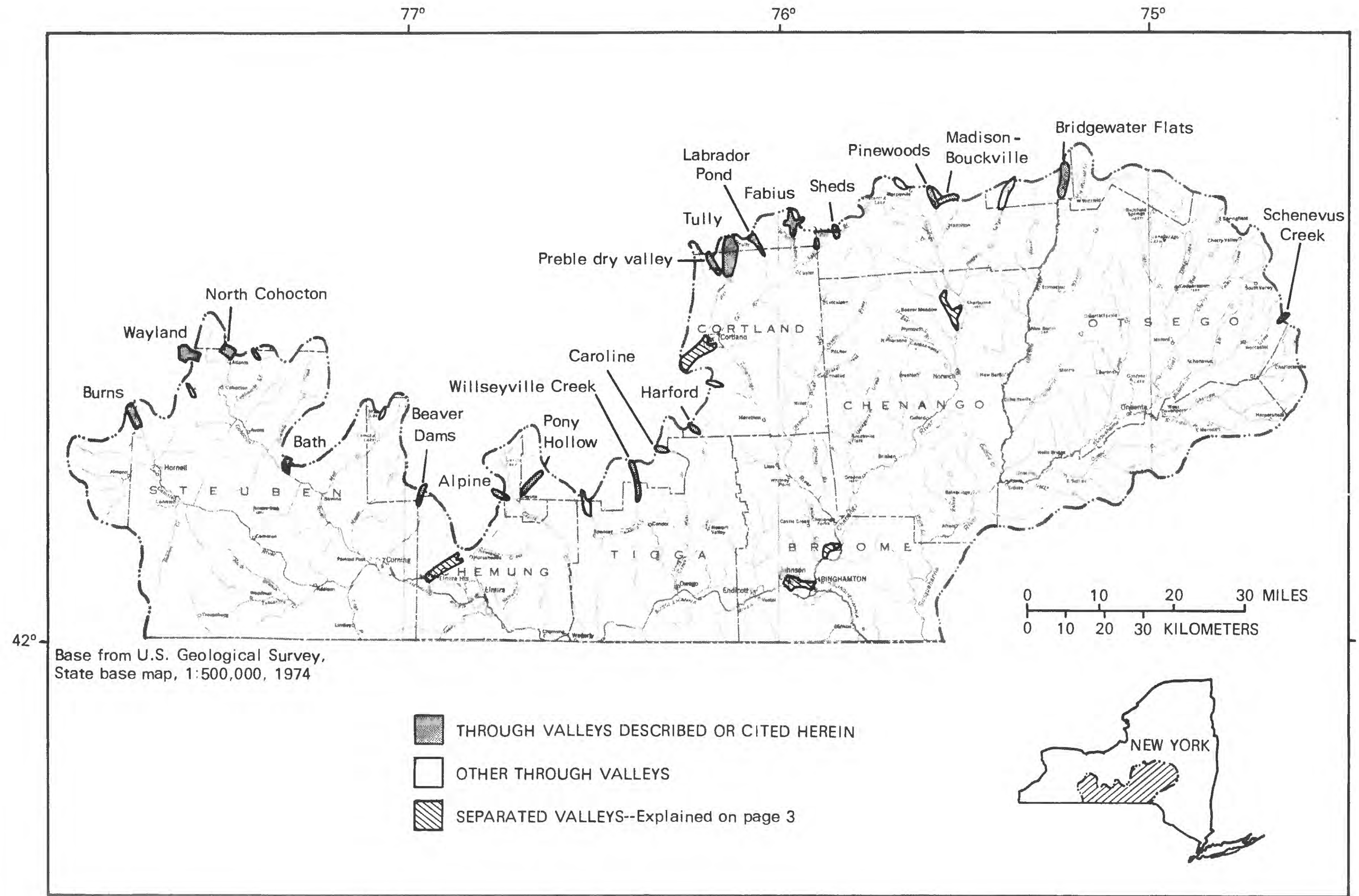


Figure 2.--Location of through valleys and separated valleys in Susquehanna River basin in New York.

and deepened these gorges. Although the glacier spread across hills and valleys throughout this region, it eroded most effectively in the valleys, where it was thickest and flowed most rapidly. By the time the last ice sheet retreated, the former saddles had long since been obliterated, and meltwater could easily flow southward into the Susquehanna basin, carrying sediment that settled in the deepened valleys to form layers of sand, gravel, and, in many places, silt and clay. All of these layers are known collectively as "stratified drift." The upper layers of stratified drift are predominantly sand and gravel and have a gentle southward slope. Sand and gravel layers near land surface and at greater depth constitute permeable aquifers that extend continuously across the former saddle and beneath the modern topographic divide, although they are truncated by steeply incised streams a short distance north of the divide in many valleys.

Recharge and Discharge Under Natural Conditions

Through valleys, despite their unusual form and complex origin, resemble other headwater valleys in that all runoff originates locally. Streams are often dry or absent in through valleys, however, especially near the divide, and streams that do flow are either sources of local ground-water recharge or products of local ground-water discharge. Small tributaries that descend to the valley floor from adjacent hills lose water as they cross stratified drift (Ku and others, 1975 p. 14; Randall, 1978), and their lower reaches are dry for much of the year. Ground water is derived from these tributary losses, as well as from precipitation on the stratified drift, and drains downvalley as underflow. The rate of underflow gradually increases downvalley until it exceeds the water-transmitting capacity of the stratified drift, at which point the water table necessarily intersects land surface near the valley axis, and ground water is discharged to form a stream (fig. 3A).

During the summer, the water table in the headwater reach subsides because ground water continues to drain downvalley as underflow and is not replenished because high rates of evapotranspiration prevent recharge from precipitation and reduce tributary flow. As the water table subsides, the point at which it intersects land surface migrates downvalley (fig 3A), leaving a dry channel upvalley. The stratified drift in such a valley constitutes a ground-water reservoir well suited to intermittent or seasonal ground-water development without greatly reducing streamflow, as explained below.

Seasonal Ground-Water Development

Large-scale ground-water development in a through valley would require that several wells tap the stratified-drift aquifer near the divide and for some distance downvalley. The number, layout, and design yield of wells would depend on aquifer properties, on where the water may be needed, and on economic considerations. For purposes of illustration, a line of wells is postulated along the valley axis in figure 3B (an actual layout would doubtless be more complex). Large ground-water withdrawals during the summer would lower the water table near the divide and would reduce ground-water discharge to the head of the tiny master stream draining downvalley, and perhaps also to an equally small headwater stream north of the divide. At the end of the period of seasonal need, the pumps would be shut off, and recharge during the

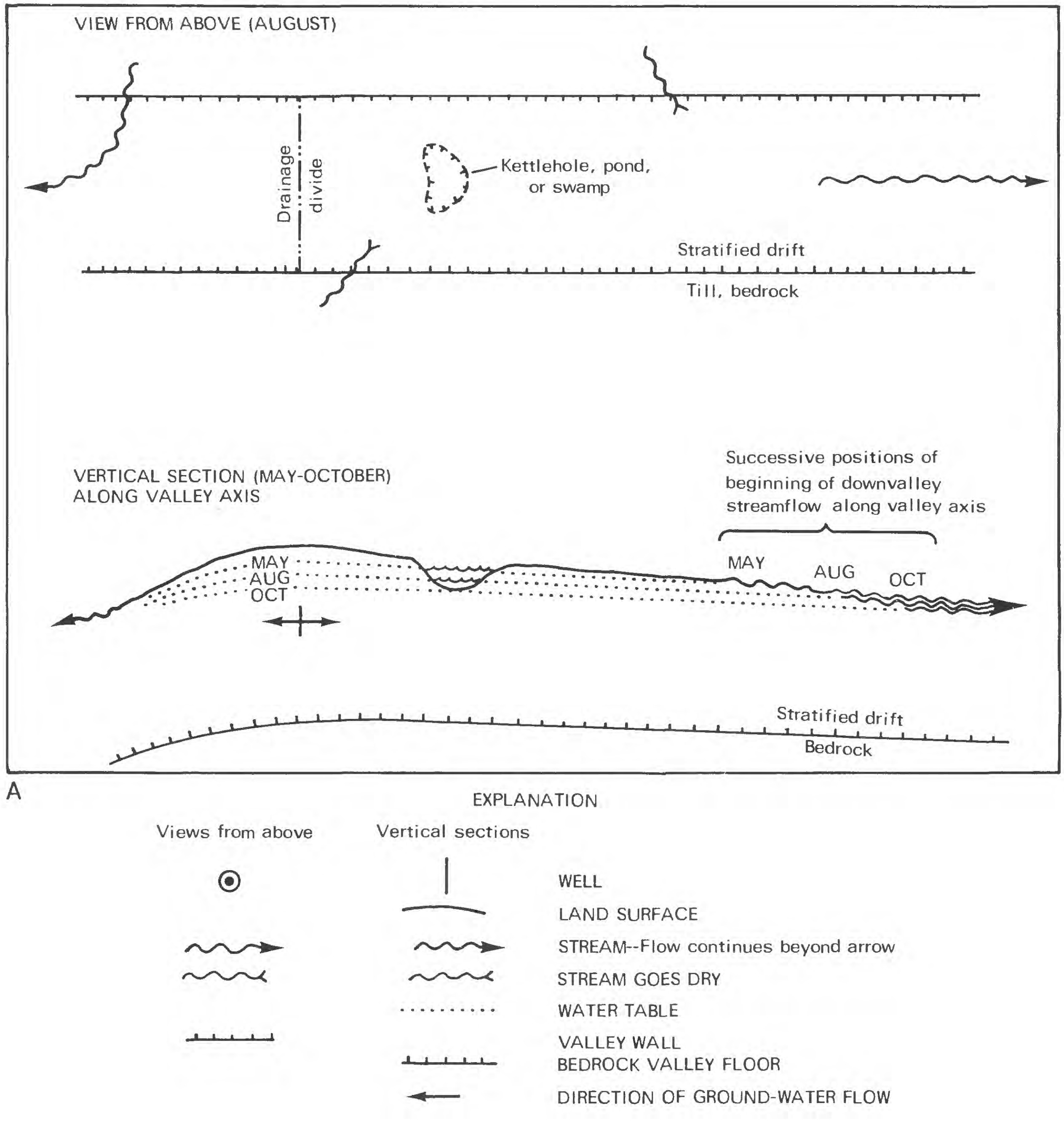
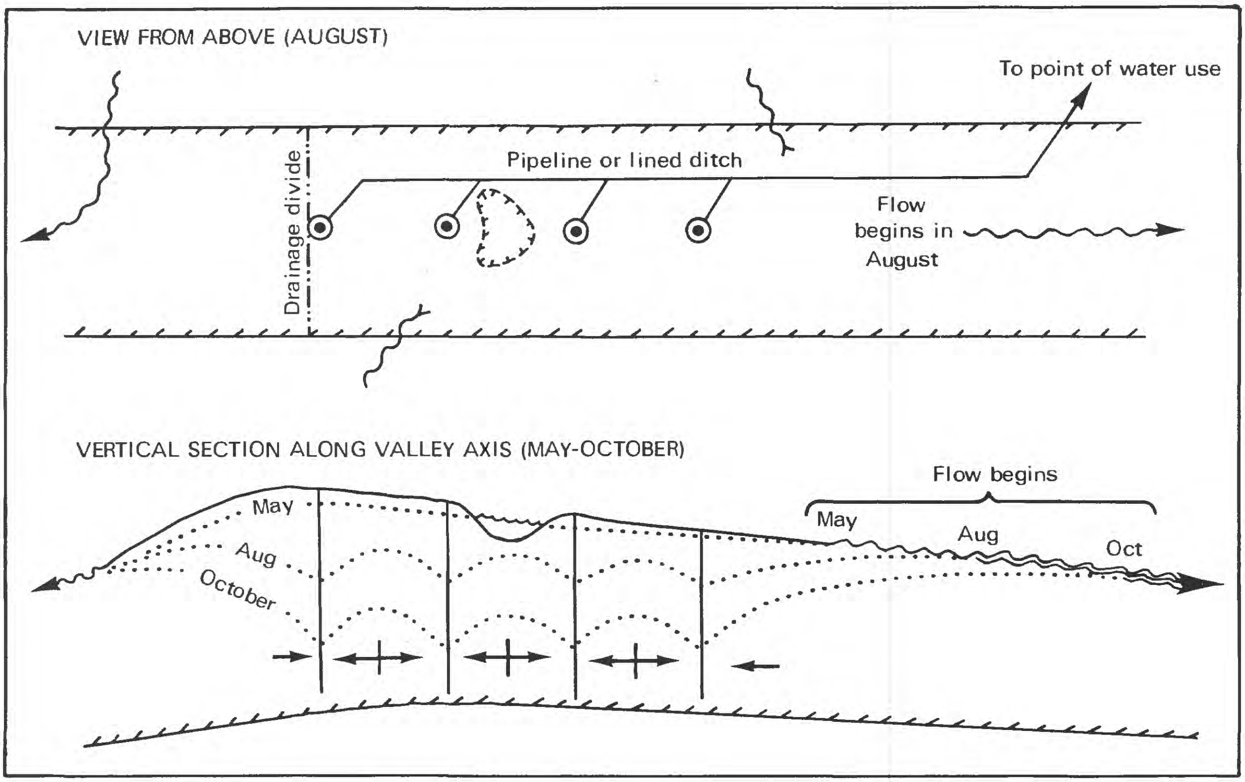
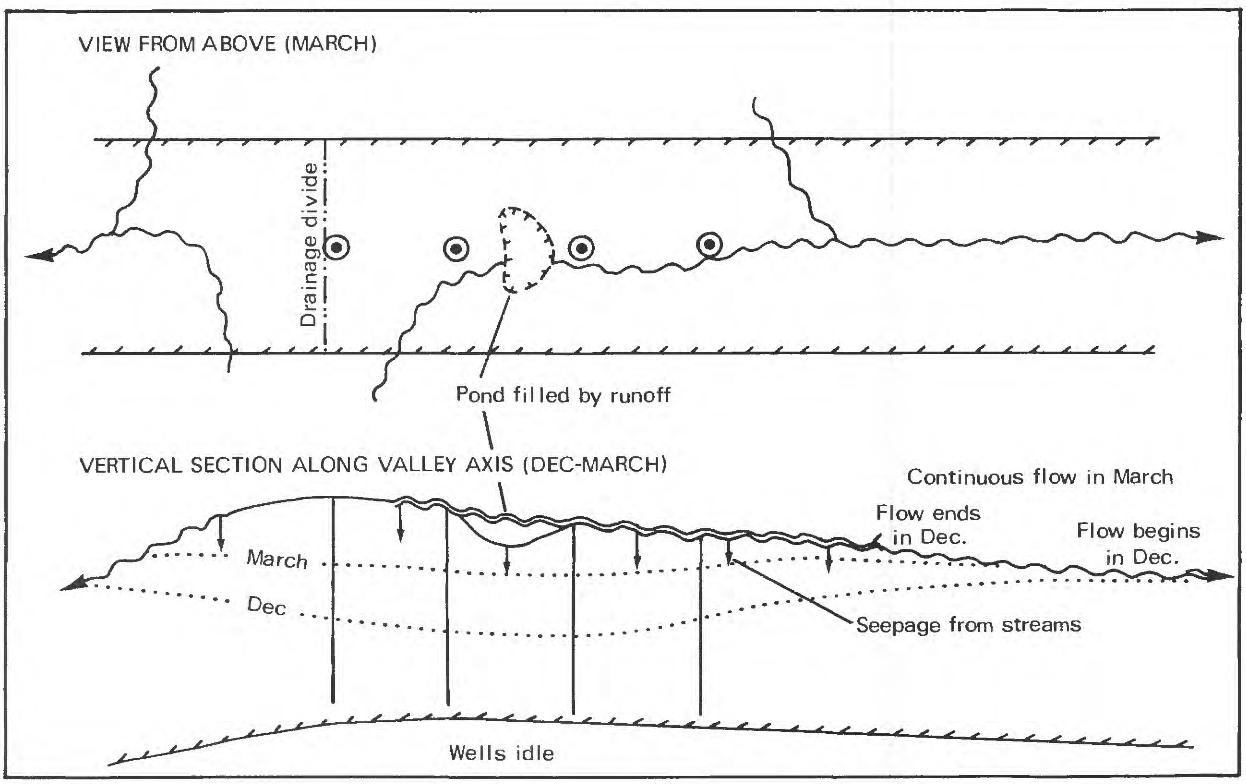


Figure 3.--Plan views and longitudinal sections showing ground-water levels and directions of flow in an idealized through valley: A. In summer, under natural conditions. B. In summer, with seasonal ground-water development. C. In winter, after seasonal ground-water development in summer.


VIEW FROM ABOVE (AUGUST)
To point of water use
Pipeline or lined ditch
Drainage divide
Flow begins in August
VERTICAL SECTION ALONG VALLEY AXIS (MAY-OCTOBER)
Flow begins
May
Aug
October
May
Aug
Oct

B


VIEW FROM ABOVE (MARCH)
Drainage divide
Pond filled by runoff
VERTICAL SECTION ALONG VALLEY AXIS (DEC-MARCH)
Continuous flow in March
Flow ends in Dec.
Flow begins in Dec.
March
Dec
Seepage from streams
Wells idle

C

following winter and spring would gradually refill the water-table depression (fig. 3C). Abnormally large or prolonged seepage losses from streams could be expected then, but these losses would be only a small percentage of the high streamflow that occurs during this period and hence would be of no consequence.

The seasonal yield of such a subsurface reservoir system would be limited principally by three constraints:

1. The extent to which lowering of the water table and dewatering of any perennial stream, ponds, or wetlands would be acceptable.
2. The aquifer properties, which determine well yield and also the extent of the cone of depression for any given rate and duration of pumping, hence indirectly determine the resulting reduction in streamflow.
3. The rate at which the aquifer refills. This rate might vary from year to year as a result of random variations in precipitation but would depend principally on the extent to which recharge during the winter and spring exceeds the normal rate until the water recovers to its normal altitude.

QUANTITATIVE ANALYSIS OF SEASONAL YIELD FROM A TYPICAL THROUGH VALLEY

The foregoing discussion sets forth the principles involved in using through valleys as underground storage reservoirs but gives little information as to how much water might be available for use. To provide a quantitative example, recharge and seasonal changes in storage in a typical through valley were calculated from streamflow and water-level measurements, and the results were used to calibrate a digital model with which the effects of seasonal ground-water withdrawals in the valley could be simulated.

The valley selected is largely in the Town of Harford, in Cortland County between Dryden Lake and Harford Mills (fig. 2). This valley was selected for three reasons:

1. Its configuration is simple and resembles that of the idealized through valley depicted in figure 3 in that it is underlain largely by permeable stratified drift and has no forks, branches, lakes, or large swamps, and only small tributaries.
2. Much of the land is owned by the New York State College of Agriculture and Life Sciences and thus was accessible for research.
3. Considerable data (including precipitation, well records, test-well logs, water-level and streamflow measurements) were available from various published and unpublished sources (New York Climate Office, 1979-80; Dr. David Bouldin, New York State College of Agriculture and Life Sciences, written commun., 1980-81; files of U.S. Geological Survey, Albany, N.Y.).

The choice of Harford valley for quantitative study does not in any way imply that this valley is more suitable than other through valleys for use as an underground storage reservoir. Such a determination would require more detailed hydrologic study of other valleys and would also involve questions of competing demands for water and economic considerations that are outside the expertise and mission of the U.S. Geological Survey. Development and application of the model of Harford valley was by D. S. Snavely and was based in part on earlier unpublished studies by A. D. Randall.

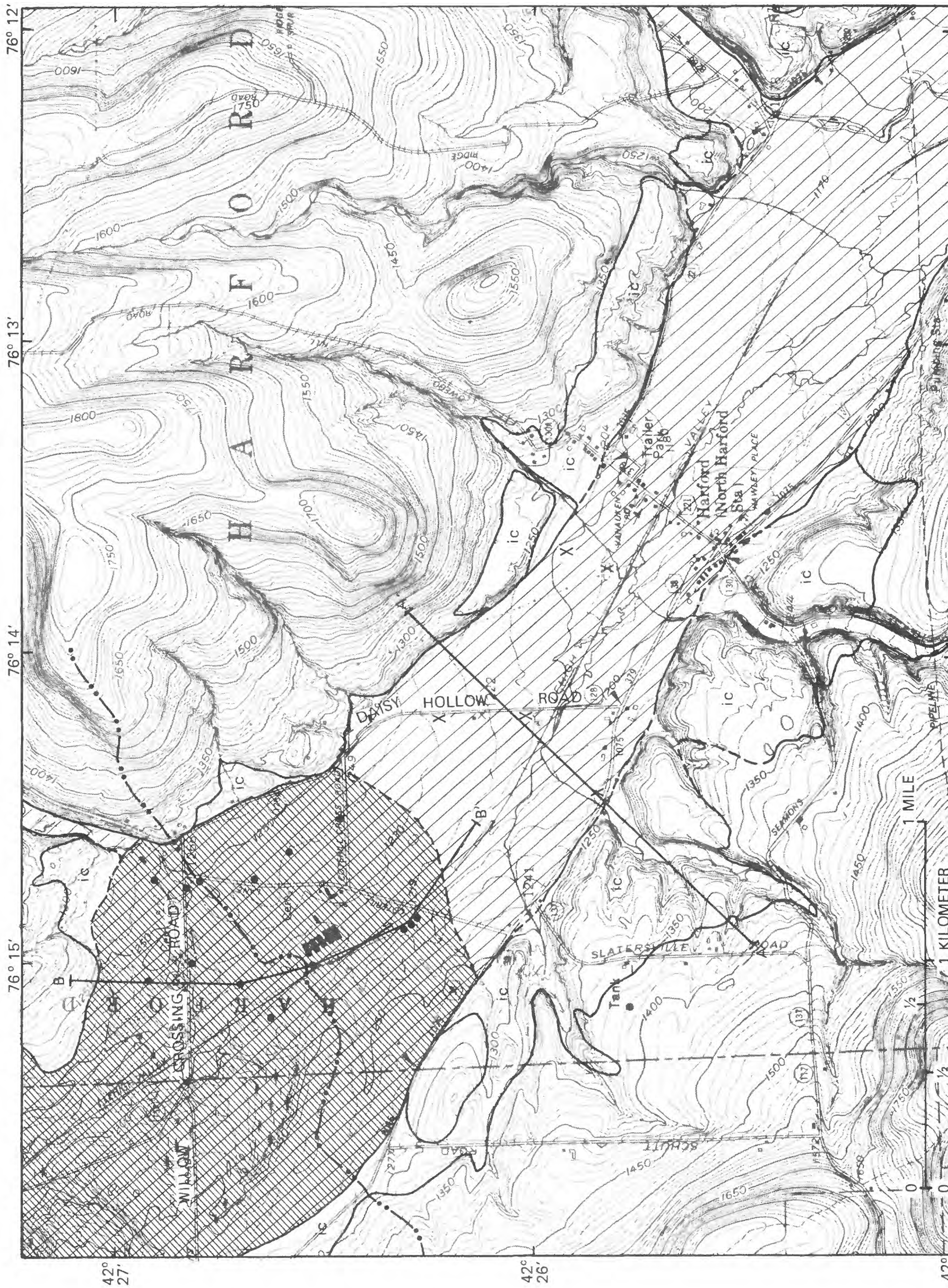
Surficial Geology

The distribution of unconsolidated deposits along the Harford valley (fig. 4) is closely related to the shape of the land surface and to the history of glaciation. The uplands that border the valley consist of bedrock mantled with till (an unstratified mixture of silt and clay with lesser amounts of sand and stones) that was deposited directly from the last ice sheet when it covered the region. The unweathered till that lies only a few feet beneath the land surface has extremely low permeability, so most of the precipitation that falls on the uplands either returns to the atmosphere by evapotranspiration or runs off to streams, partly over the land surface but mostly within the upper foot or two of soil, which is relatively loose and permeable as a result of weathering.

The sides of the Harford valley consist largely of smooth, till-mantled bedrock slopes, but many of the lower slopes are flanked by terraces and irregular knolls that formed when the uplands were ice-free but ice still occupied the valley. Stratified drift accumulated in temporary lakes and stream channels between the ice tongue and the valley walls at altitudes of 1,480 to 1,260 feet. Exposures and records of four deep wells that penetrate these ice-contact deposits reveal layers of gravel, commonly silty, that are interlayered with much fine sand and silt. Maximum thickness may exceed 350 feet (fig. 5).

As the last ice near Harford melted, a thick, eastward-sloping wedge of sand and gravel, referred to as outwash, was deposited by meltwater flowing away from ice that remained active northwest of Willow Crossing Road (fig. 4), where the bedrock surface is deeper. Many wells and test holes between Willow Crossing Road and Harford have penetrated clean to silty gravel to depths of 50 to 80 feet. Near the divide, however, a layer of till 5 to 10 feet thick lies a few feet below the surface of the outwash and appears to be continuous beneath the area shown in figure 4. A second, slightly deeper layer of till and(or) lacustrine silty clay underlies at least part of the same area (fig. 5). These till layers presumably resulted from brief readvances of the fluctuating ice margin. The presence of clay suggests that whenever the ice margin withdrew, water became ponded between the ice and the outwash.

While the outwash was being deposited, and after the flow of ice and meltwater into Harford valley ceased, tributary streams incised valleys into the upland till and ice-contact deposits and redeposited the resulting sediment on the valley floor, largely as alluvial fans. The upper 10 to 25 feet of sediment on the fans is predominantly silty gravel, richer in local shale pebbles than the underlying outwash gravel. Although the alluvial fans are partly postglacial and generally siltier than gravel in the underlying deposits, they are grouped together with ice-contact deposits and outwash under the broad term "stratified drift" in the hydrologic analysis that follows.



Base from NYSDOT, Dryden, NY, 1978, and Harford, NY, 1973, 1:24,000

Figure 4.--Surficial geology of the Harford valley. Geologic contacts based on soils map (Sery, 1961), topographic map, and a few field observations.

EXPLANATION

DRAINAGE DIVIDE

TILL--Includes small areas of bedrock outcrop and probably a few areas where the till is thinly mantled by stratified drift

STRATIFIED DRIFT:

ic ICE-CONTACT DEPOSITS--Includes thin postglacial alluvium along entrenched streams

OUTWASH--Widely mantled by postglacial alluvial fan deposits

AREA WHERE TILL LAYER(S) UNDERLIES OUTWASH AT SHALLOW DEPTH--Top of till is generally 5 to 15 feet below land surface

• TILL OBSERVED BENEATH STRATIFIED DRIFT--In test well or exposure

X TILL ABSENT IN TEST WELL

CONTACT--Dashed where approximate

A A' LINE OF SECTION--Sections shown in figure 5

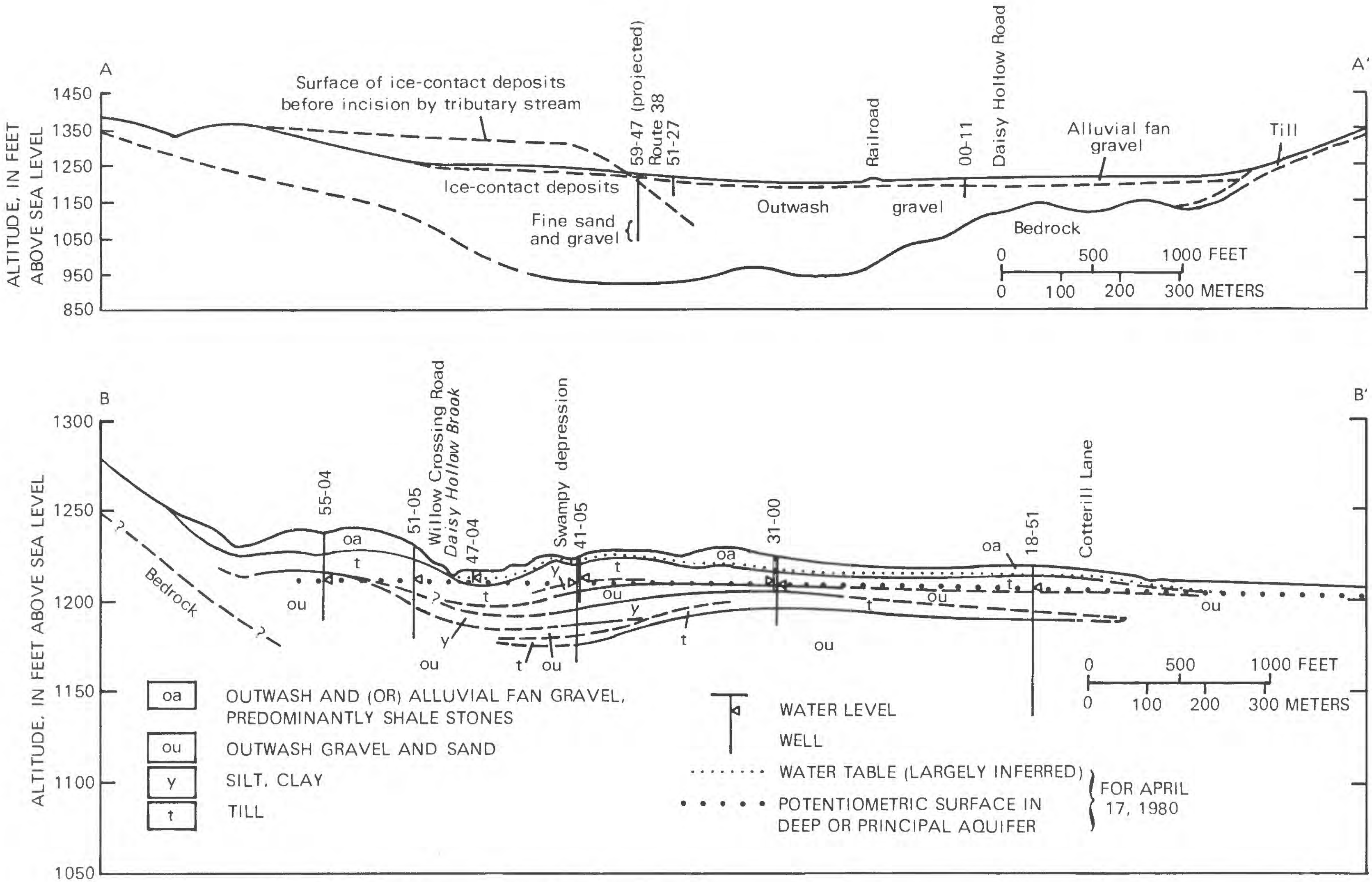


Figure 5.--Geologic sections in Harford valley:

Section A-A' is across valley near Daisy Hollow Road. Bedrock surface, where drawn as solid line, is based on seismic-refraction profile; seismic data collected by arrangement with F. VanAlstyne, New York State Department of Environmental Conservation and interpreted by R. J. Reynolds, U.S. Geological Survey, using computer program by Scott and others (1972).

Section B-B' is at an angle to valley near Cotterill Lane; it illustrates interbedding of till, clay, and outwash in upper part of valley fill.

Location of sections and test wells shown on figure 4. Wells are identified in figure 6.

Hydrology

Interaction Between Ground Water and Surface Water

The distribution of streamflow in the Harford valley is a function of geologic conditions. Small streams originating in the till-mantled uplands lose water by seepage as they flow across the stratified drift; the point at which loss begins probably depends on the depth to till and bedrock but fluctuates slightly through time (Randall, 1978). During much of the year, most upland tributaries cease flowing shortly below where they begin to cross the stratified drift but above the outwash on the valley floor. Figure 6A shows a typical stream network. Daisy Hollow Brook, which enters the valley just west of the topographic divide and turns northwest to Dryden Lake, normally flows farther into the valley before going dry than the other tributaries, probably because the till layer at shallow depth (fig. 4) limits the rate at which ground water can seep away from the channel.

For several days each year during the spring freshet and occasionally at other times of unusually heavy rain, the hillside tributaries carry water all the way across the valley floor; ponds form temporarily in low-lying areas, and eastward flow along the axis of the valley begins just west of Cotterill Lane. Figure 6B shows the extent of the stream network a few days after the last of several runoff peaks in March and early April 1980 and suggests the maximum extent of the network under peak-runoff conditions.

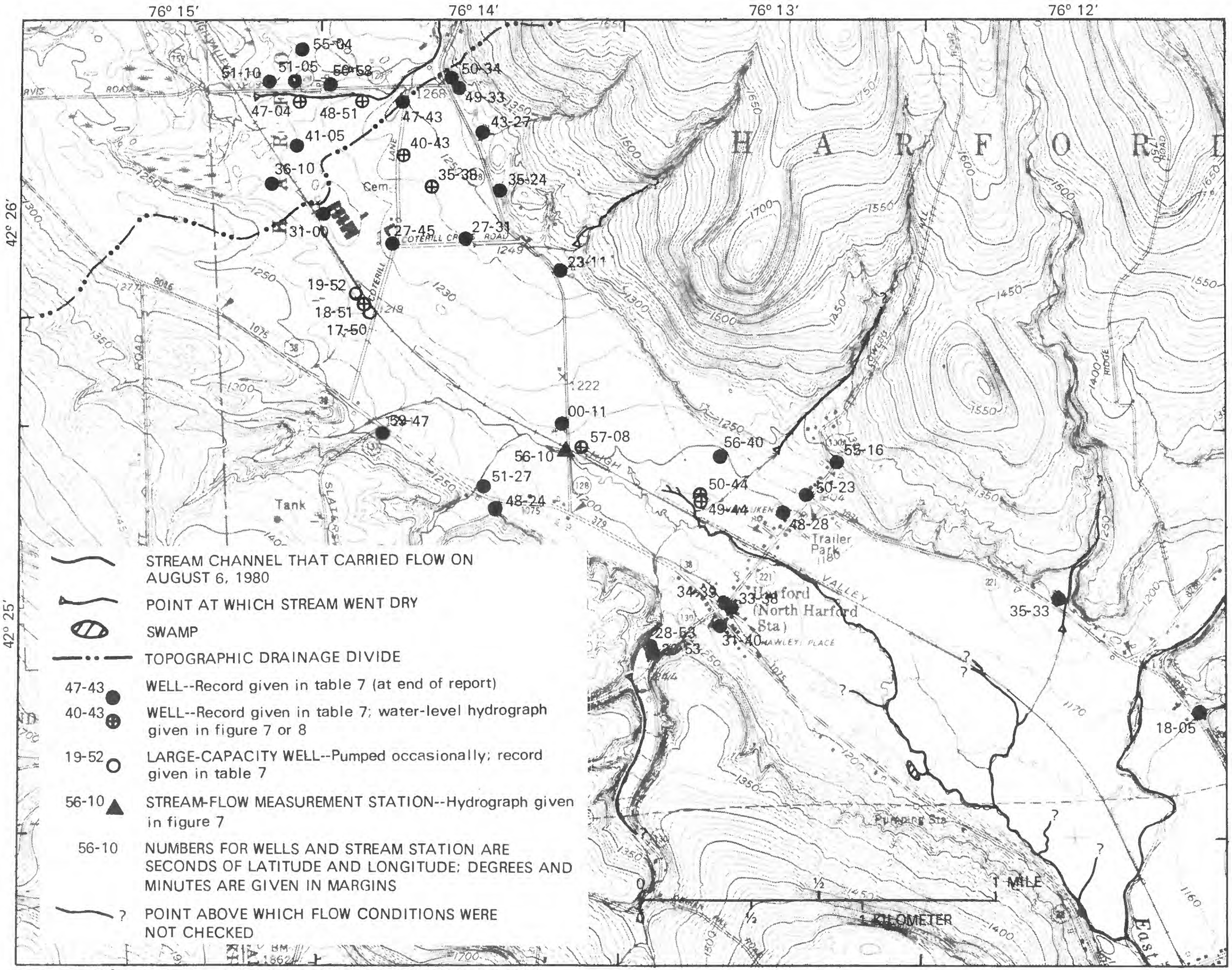
Loss of water from stream channels by seepage is an important source of recharge to ground water in the stratified drift. Tributary streams lose water at all times; the dry reaches along seven of the eight tributaries to the main stem west of Harford on April 17, 1980 (fig. 6B) are evidence that even at times of moderately high flow, much of the water carried by these tributaries becomes recharge.

Surface flow eastward along the valley axis generally consists of ground-water discharge. Flow normally begins in a narrow wetland 1,500 to 2,500 feet upstream of the Route 221 bridge at Harford (fig. 6A). Even in April, all flow downstream from dry reaches of the tributary channels (fig. 6B) is water that seeped out of the underlying aquifer. The main stem becomes a source of ground-water recharge during most periods of high runoff, however, as explained below.

The interaction between surface water and ground water in the stratified-drift aquifer is illustrated in figure 7 (p. 19), which compares stage in the mainstem at Daisy Hollow Road with water levels in a nearby well from February 1979 through February 1980. The 13 months represented in figure 7 may conveniently be grouped into six time periods, as follows:

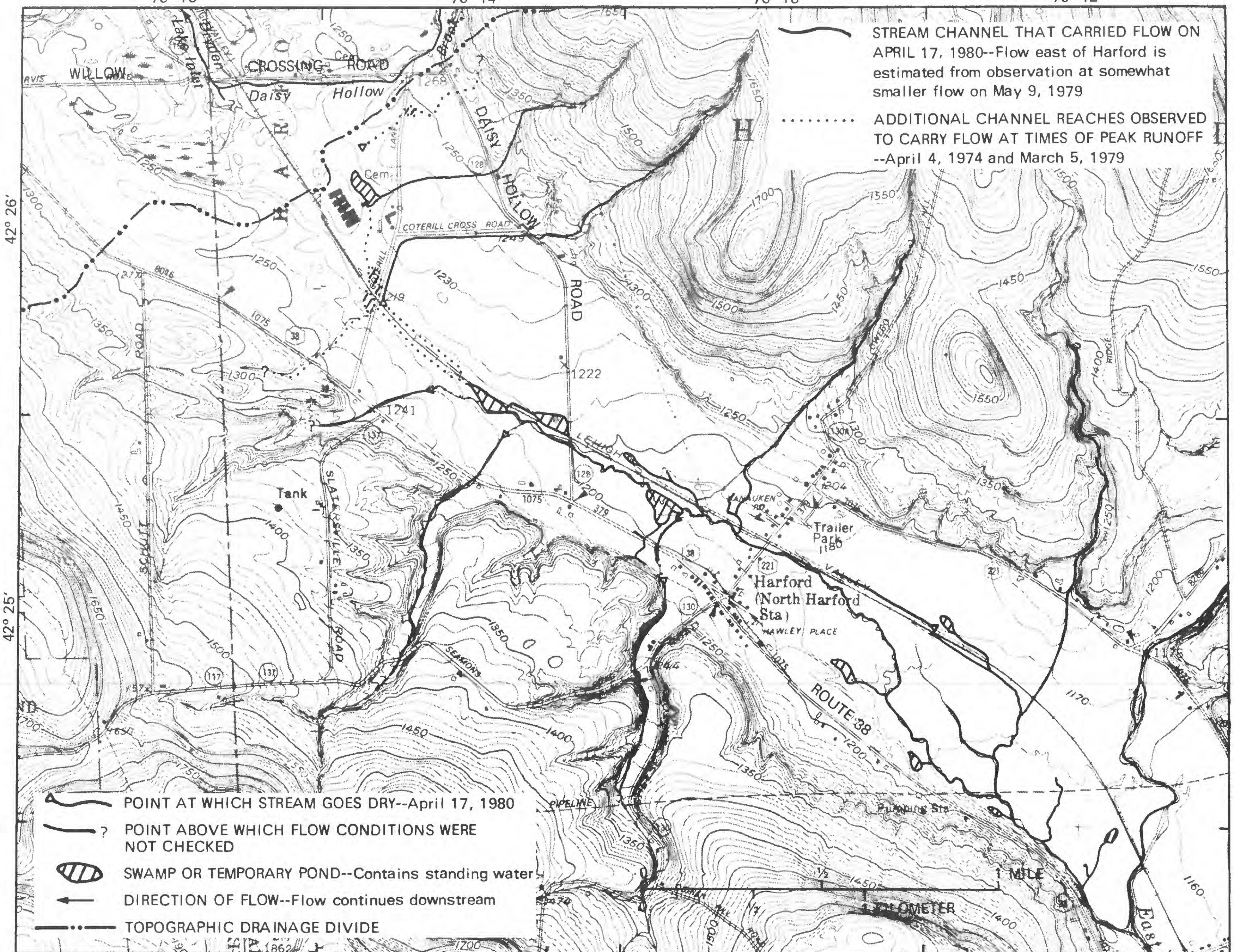
1. February 1979. Surface runoff from the uplands was negligible because air temperature was mostly below freezing. The water table declined steadily.

2. Late February through early March. Warmer temperatures after February 24 and heavy rain on February 25 and March 5 resulted in the annual spring freshet. The mainstem carried surface runoff from the uplands downvalley past Daisy Hollow Road for the first time, and stage rose to a peak about 3 feet above the channel bed. Seepage losses from the stream caused an abrupt 4-foot rise in the water table.



Base from NYSDOT, Dryden, NY, 1978, and Harford, NY, 1973, 1:24,000

Figure 6A.--Stream network in Harford valley on August 6, 1980, and location of wells.



Base from NYSDOT, Dryden, NY, 1978 and Harford, NY, 1973, 1:24,000

Figure 6B.--Stream network in Harford valley on April 17, 1980.

3. March 5 through at least April 22. The aquifer was saturated up to stream grade near the valley axis. Surface flow was continuous at Daisy Hollow Road and consisted of runoff from the upland (when tributary flow was high after rainfall or snowmelt) and ground-water discharge from immediately upstream (when flow began below Cotterill Lane, as in fig. 6B). The water table fluctuated within a narrow range and declined somewhat during periods when streamflow was derived from ground-water discharge.

4. Late April through early October. Near the end of April, streamflow ceased at Daisy Hollow Road, indicating that the water table had dropped below stream grade along the valley axis upvalley. The water table declined until early October as ground water flowed downvalley toward springs 1,500 feet northwest of Harford, the nearest point of discharge.

5. October through December. An inch or more of rain fell during each of four storms after September 1, as indicated in the table below. Three of these storms caused the water table to rise abruptly 1 to 3 feet (fig. 7), and a smaller storm on December 24-25, perhaps augmented by snowmelt from the hills, produced a similar effect. The magnitude and abruptness of the water-table rises indicate that a principal source of recharge was stream seepage during brief episodes of flow past Daisy Hollow Road, by the following reasoning. Unsaturated sand and gravel typically contains 10 to 25 percent air-filled pore space available to be filled with water as the water table rises. If this pore space (specific yield) were only 10 percent, and if all precipitation in a given storm were to reach the water table, the water table would rise 10 times the depth of rainfall; if specific yield were 25 percent, the water table would rise 4 times the depth of rainfall. This relationship, and the fact that some precipitation would not reach the water table if soil moisture were depleted before the storm, indicate that a water-table rise of much less than 10 times the rainfall depth could ordinarily be expected in an outwash aquifer. Water-table rises much larger than tenfold were observed after storms in the fall of 1979, however, as indicated in the table below. The additional water required to produce these large rises was presumably seepage from the stream, only 75 feet away. Stage measurements showed that the November 25-26 storm did, in fact, cause runoff to flow past Daisy Hollow Road briefly, and the other storms in October, November, and December are inferred to have done likewise. The absence of an appreciable response to the September 3-6 storm suggests that the channel remained dry near Daisy Hollow Road; perhaps runoff was small because most of the precipitation replenished soil moisture in the upland watersheds during this first large storm of the fall, or perhaps seepage losses were relatively great along the channel upstream from Daisy Hollow Road after a long period of dryness.

Date of storm (1979)	Precipitation (inches)	Precipitation (feet)	Rise in water table near valley axis (fig. 7) due to storm (feet)	Rise in water table near valley axis (fig. 7) due to storm (feet per foot of precipitation)
September 3-6	2.73	0.228	Negligible	0
October 5-6	1.87	.156	1.30 or more	8.3 or more
November 2	1.08	.090	2.15	22
November 25-26	1.60	.133	3.10	23
December 24-25	.27	.023	1.80	78

6. January-February 1980. Negligible precipitation and low temperatures resulted in generally steady water-table decline as ground water continued to drain downvalley.

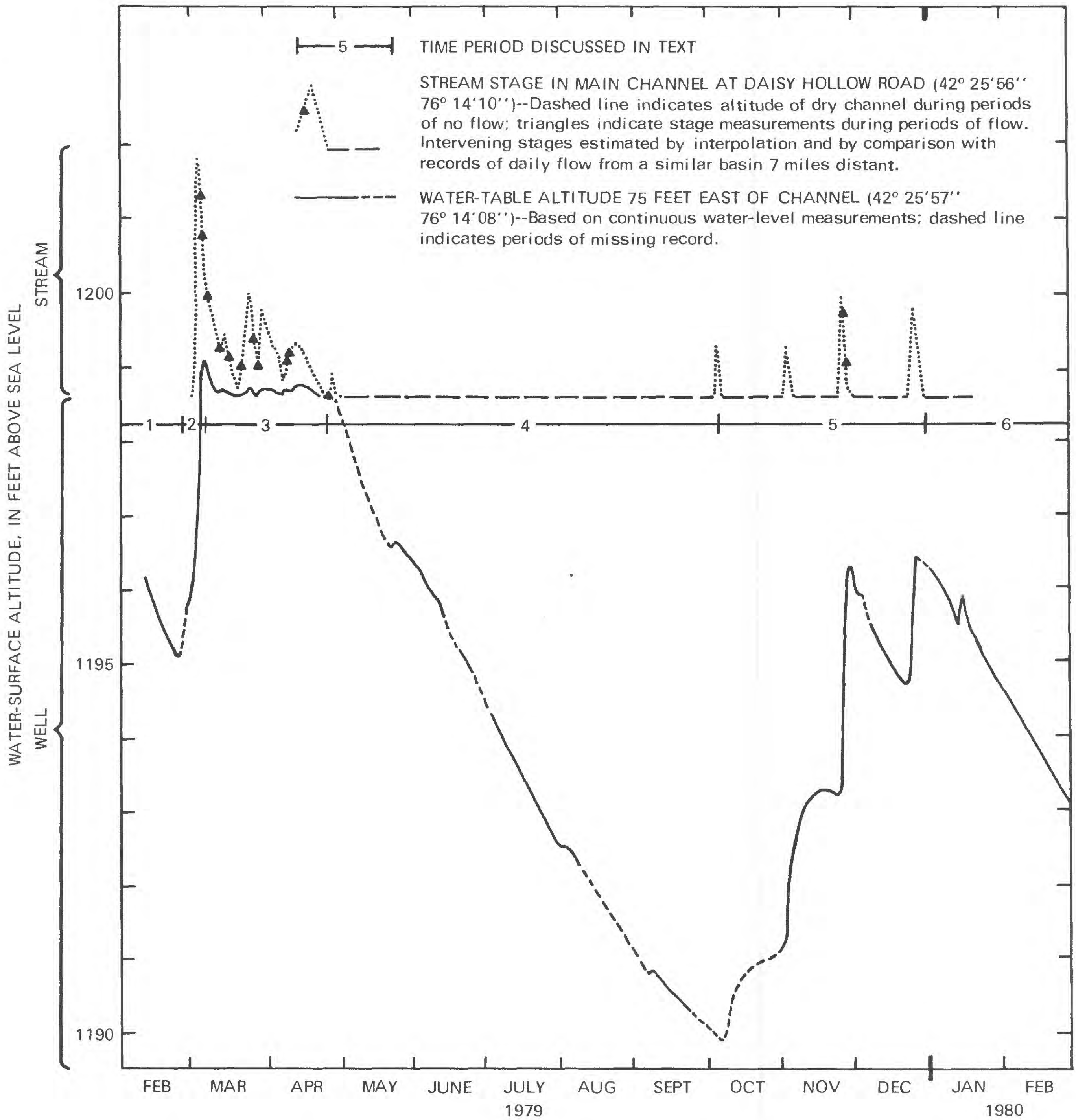
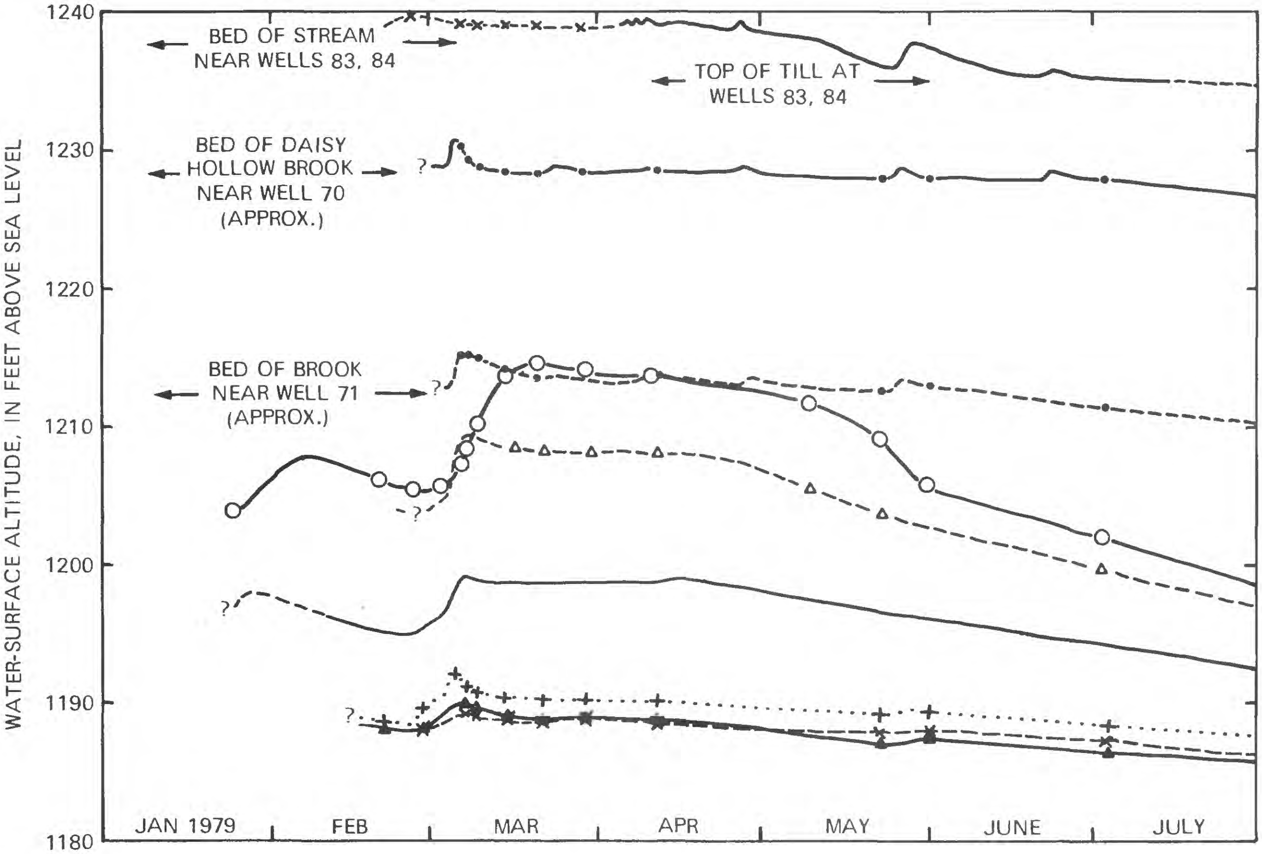


Figure 7.--Stream stage and water-table altitude near the stream in the headwater reach of Harford valley, where streamflow is intermittent. (Location of measurement sites shown in fig. 6A.)



EXPLANATION

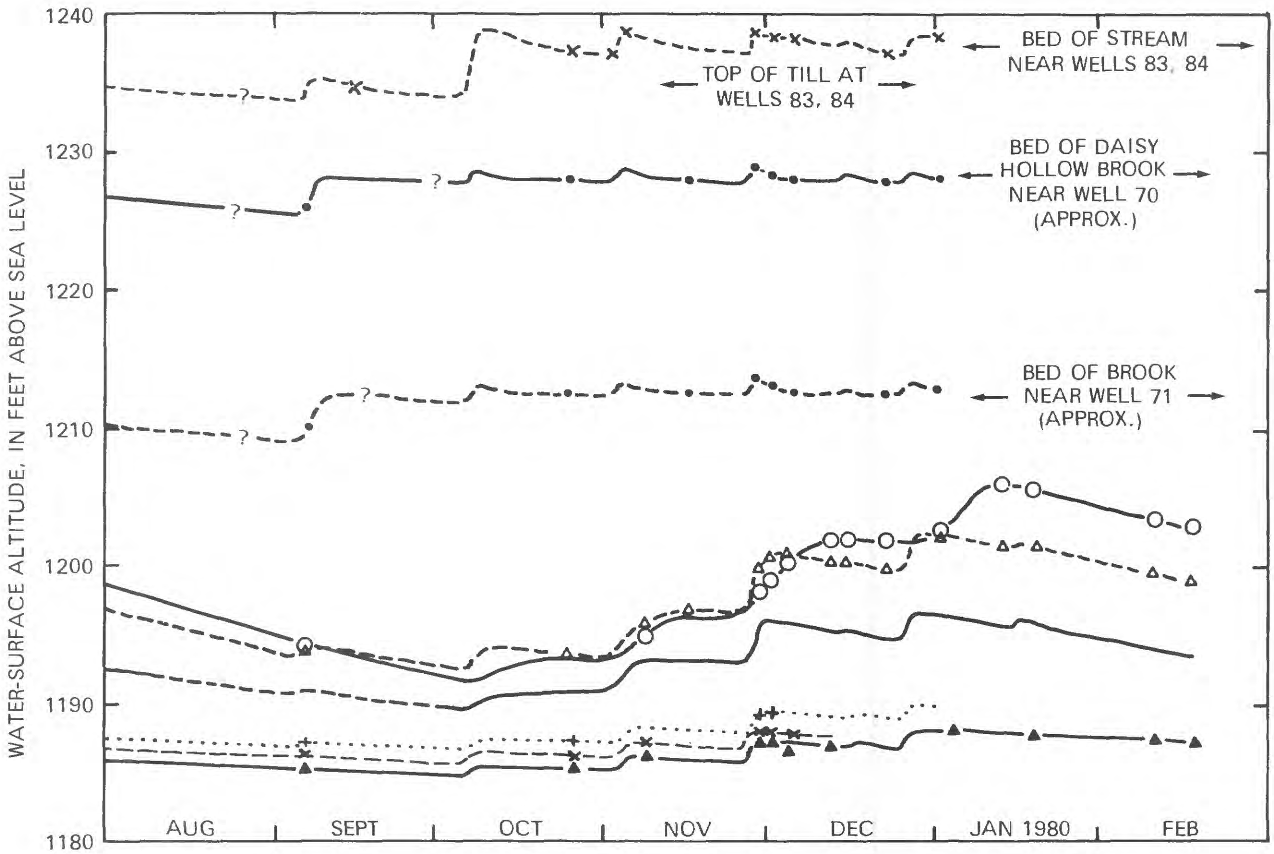
Wells listed in order from upvalley (northwest) to downvalley (southeast). Dates of water-level measurement indicated by point symbols; water levels between symbols are inferred except as noted below.

Symbol	New York State College of Agriculture site number	Location (fig. 6) Latitude ° ' "	Longitude ° ' "	Well depth (feet)	Note
—•——•—	70	4226 48	7614 51	9	--
--•--•--	71	4226 47	7615 04	8	--
—o—o—	73	4226 40	7614 43	52	--
-x--x——	83, 84	4226 35	7614 38	8, 9?	a
--△--△--	236	4226 18	7614 51	-	--
————	93	4225 57	7614 08	10.5	b
···+······+···	96	4225 50	7613 44	7.0	--
-*---*-	97	4225 49	7613 44	23	--
—▲—▲—	98	4225 49	7613 44	48	--

[a] Solid line indicates continuous hydrograph record, dashed line indicates intermittent measurements at X symbols.

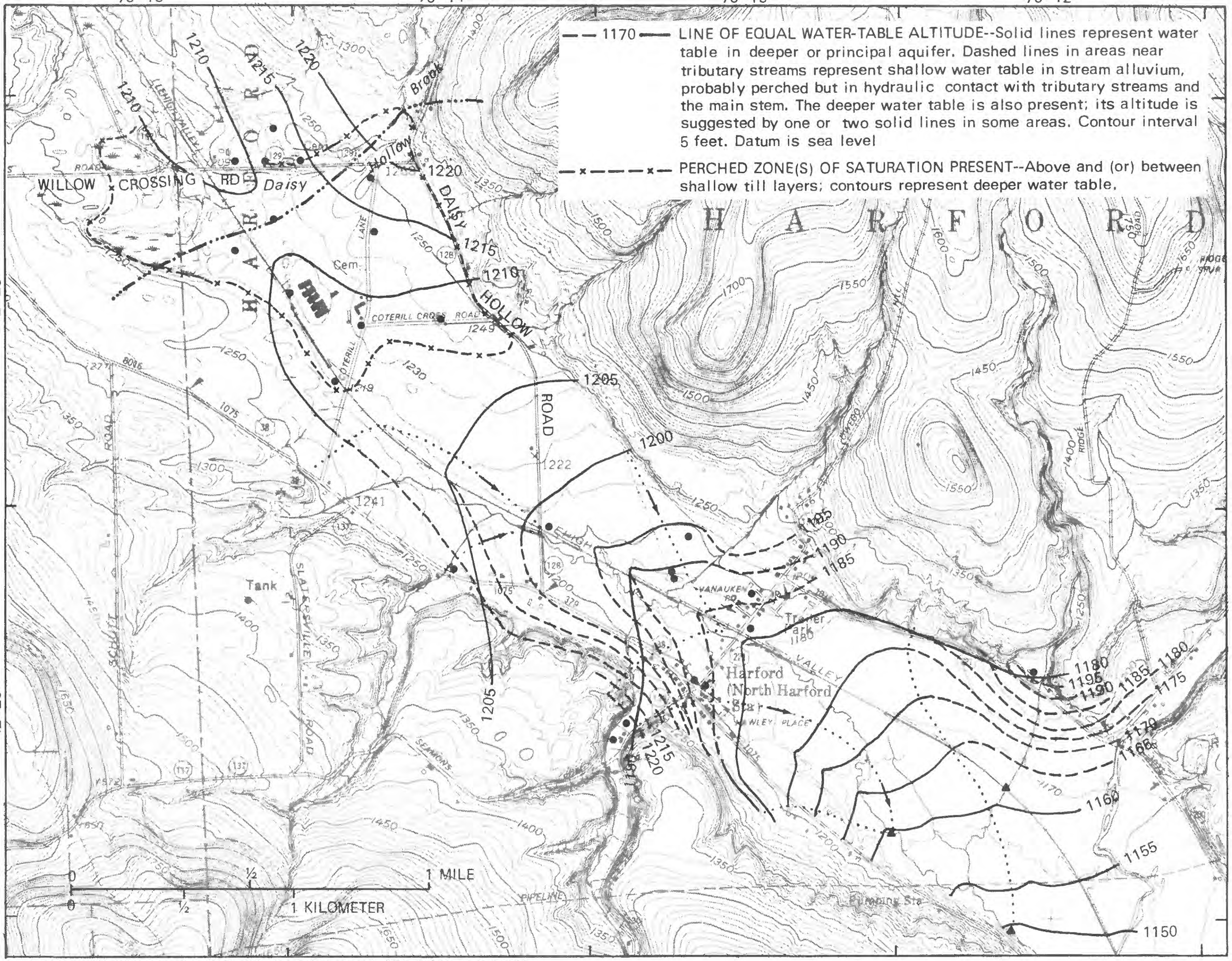
[b] Solid line indicates continuous hydrograph record, dashed line indicates no record; same hydrograph as figure 7.

Figure 8.--Hydrographs of several observation wells in Harford valley.



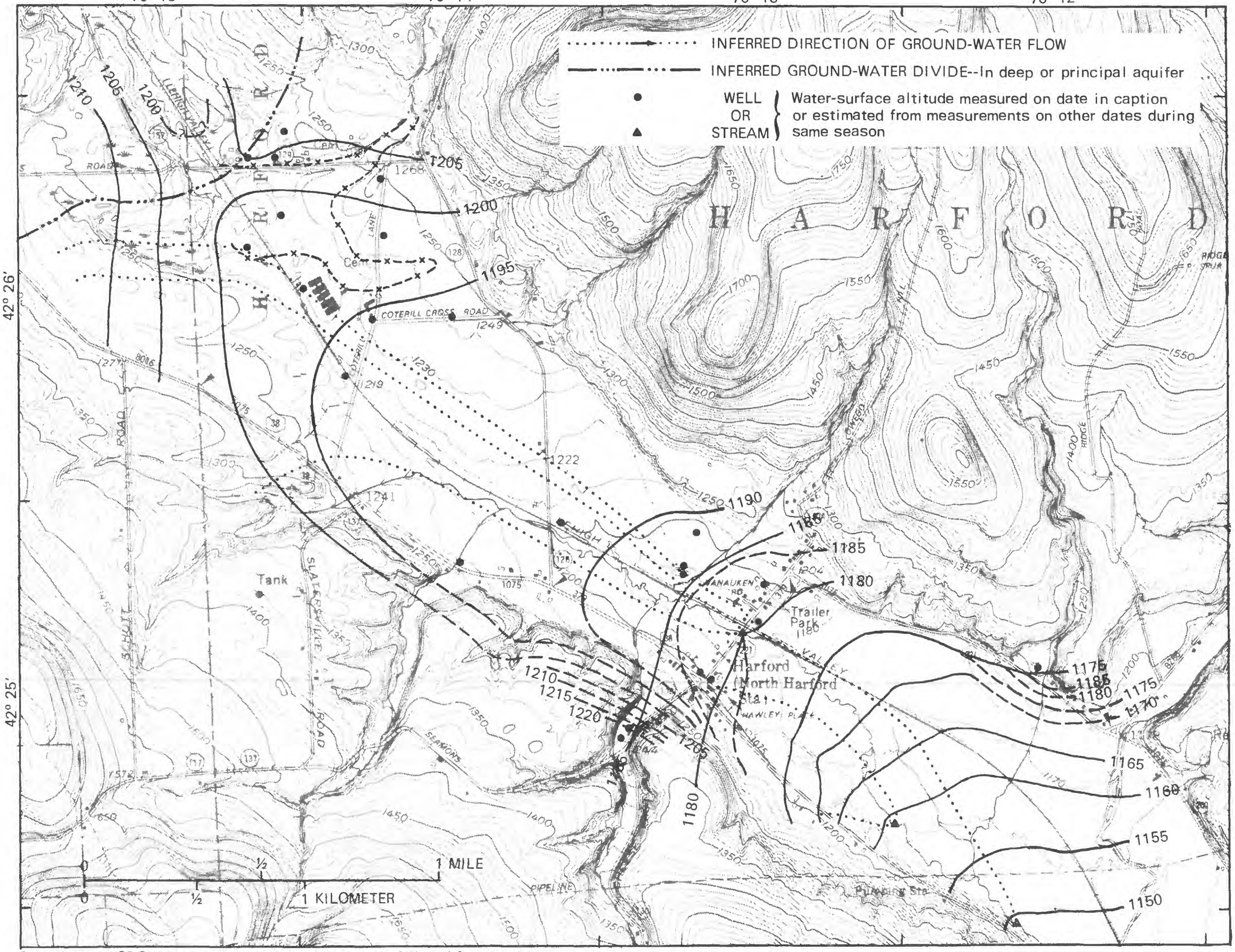
Several other generalizations concerning ground water in Harford valley may be drawn from water-level records. Although the water-table altitude declines substantially from spring to fall, the direction of flow seems not to change greatly in most places (fig. 9). The location of the ground-water divide in the principal aquifer is reasonably well defined by available records; it shifts seasonally but remains slightly west of the topographic divide. Water that reaches the principal aquifer near Daisy Hollow Brook generally flows eastward toward Owego Creek. The annual water-level fluctuation within the principal aquifer increases upvalley, as illustrated by the lower six hydrographs in figure 8. The annual fluctuation is 5 feet or less near Harford, where flow is perennial, but is 15 or 20 feet near Cotterill Lane and perhaps also in the stratified drift southwest of Route 38. (The upper three hydrographs represent water levels above the till layer, which behave differently, as described later on.) Although well 236 is normally downgradient from well 73, the water level in the principal aquifer was slightly higher near well 236 than near well 73 during brief periods of generally rising water levels in the fall of 1979 (fig. 8). This may reflect greater recharge near well 236 because of its proximity to tributary channels. Alternatively, the till layer may be discontinuous near its east margin, which would enable recharge to reach the water table sooner near well 236 than well 73.

The three lower hydrographs in figure 8 represent wells within 100 feet of one another near an area of perennial ground-water discharge along the valley axis (fig. 6). Normally, ground-water flow at such a location would be upward as well as lateral toward the stream. Nevertheless, heads in these three wells decrease with increasing well depth, indicating some degree of downward flow. Downward flow here might result from increased aquifer permeability at depths of about 50 feet.



Base from NYSDOT, Dryden, NY, 1978 and Harford, NY, 1973, 1:24,000

Figure 9A.--Water table in Harford valley, April 16, 1980.



Base from NYSDOT, Dryden, NY, 1978 and Harford, NY, 1973, 1:24,000

Figure 9B.--Water table in Harford Valley, September 16, 1980.

The three upper hydrographs in figure 8 represent wells less than 10 feet deep, each finished in gravel at or above the top of the shallow till layer. Each is within 120 feet of a stream channel, and as long as the stream carries flow past the well, the water level in the well remains close to the altitude of the streambed (but probably below the water surface in the stream). For example, the hydrograph of wells 83 and 84 drops below streambed grade from mid-May through early October, suggesting that the small stream nearby was dry during this period; after mid-July, the hydrograph is inferred to drop below the base of the surficial gravel.

In the area underlain by till at shallow depth (fig. 4), a thin zone of saturation forms in gravel above the till every spring (fig. 8); this condition may continue throughout the year near perennial stream reaches and natural depressions. The moderately rapid rise of the principal water table after major storms (for example, wells 73 and 236, fig. 8) and the rapid seasonal dewatering of the surficial gravel layer (which is only a few feet thick) suggest that the till may be discontinuous or locally permeable and that much of the shallow ground water may drain downward through it. It is possible, however, that some recharge may be redistributed by lateral flow above the till either to the southeast edge of the till layer or northwest to the headwaters of Dryden Lake Inlet near the railroad. A shallow zone of saturation is also known southwest of Harford, within the tributary valley and alluvial fan along Cheese Factory Road. Although no till layer is evident in this area, the alluvium at a depth of 11 feet at one well (28-53, fig. 6) was a dense, clayey, silty gravel.

Ground-Water Recharge and Underflow

The rate of ground-water underflow in Harford valley was estimated from data for the 11 months from February 26, 1979 through January 25, 1980, the longest period for which ground-water levels showed zero net change and for which numerous measurements of stream stage and ground-water levels were available. Two independent methods of computation were used. The first relied on a record of daily streamflow from a similar basin 7 miles distant (Gridley Creek above East Virgil) to augment sparse streamflow data from Harford valley. Occasional measurements of stream stage and discharge at Daisy Hollow Road, a continuous record of water-table fluctuations nearby, and the record of daily flow in Gridley Creek were compared to estimate daily flow at Daisy Hollow Road, from which the volume of surface runoff during the 11-month period was computed. The valley of Gridley Creek at the gaging station is narrow and underlain by only a few feet of alluvial gravel above bedrock, so virtually all runoff must appear in the stream channel and is measured. Therefore, total runoff at Daisy Hollow Road was estimated by applying the measured rate of runoff per square mile from Gridley Creek basin to the headwater reach of Harford valley. The difference between total runoff and surface runoff was taken to represent both ground-water recharge and ground-water underflow out of the headwater reach (because water levels showed no net change).

The second method was based on streamflow measurements downstream from Harford at base flow. The gain in streamflow between measurement sites on several dates was expressed as ground-water discharge per square mile of stratified drift. An average rate of discharge per square mile for the 11-month study period was calculated by correlating discharge per square mile with water-table gradient in the headwater reach, whose average value was known.

The average rate of discharge per square mile was then applied to the area of stratified drift in the headwater reach from which discharge occurs as underflow.

Estimates of underflow by the two methods for the 11 months studied were 1.14×10^8 and 1.38×10^8 ft^3, respectively. Both methods may incorporate significant errors from extrapolated data, inferred contributing areas, and oversimplified concepts, but the computations were internally consistent and the results plausible. An underflow value intermediate between results from the two methods was combined with other hydrologic variables to compute recharge from precipitation and from upland runoff (table 1). These recharge values were subsequently used in calibrating the digital model of the aquifer.

Table 1.--Computation of recharge to stratified drift in Harford valley, February 26, 1979 to January 25, 1980.

[Computation pertains to basin upvalley from streamflow-measurement station shown in figure 6. Downvalley boundary is a line through that station perpendicular to the valley.]

Step 1: Compute net precipitation on stratified drift

29.6 inches	Precipitation February 26, 1979 to January 25, 1980[a]
+ 1.6	Water equivalent of snow on valley floor February 25, 1979[b]
- 0.1	Water equivalent of snow on valley floor January 25, 1980[c]
31.1	Net precipitation February 26, 1979 to January 25, 1980
x $.0306 \times 10^8$	Conversion factor
0.95×10^8 ft^3	Net precipitation on 1.32 square miles of stratified drift upvalley from streamflow measurement station

Step 2: Compute recharge to ground water from net precipitation on stratified drift

0.95×10^8 ft^3	Net precipitation, computed in step 1
- $.46 \times 10^8$	Evapotranspiration[d]
$.49 \times 10^8$ ft^3	Recharge to ground water from precipitation

Step 3: Compute recharge to ground water from upland runoff

1.20×10^8 ft^3	Ground-water underflow moving downvalley past streamflow measurment station[e]
+ $.02 \times 10^8$	Base flow in stream channel at station[f]
- $.49 \times 10^8$	Recharge to ground water from precipitation, computed in step 2
$.73 \times 10^8$ ft^3	Recharge to ground water from seepage loss of upland runoff in tributary streams

[a] Recorded by rain gage at meteorological station on valley floor.
[b] Old snow; depth measured at meteorological station, water content from nearest stations in 1978-79 cooperative snow survey (U.S. Geological Survey, 1979).
[c] New snow; depth and water content from records at meteorological station.
[d] Estimate; adapted from Ku and others (1975) assuming evapotranspiration of ground water to be minimal because of substantial depth to ground water in stratified drift.
[e] Value intermediate between results of two computation methods described in text.
[f] Computed as 0.6 ft^3/s during periods of declining water table March 1 to April 30 (fig. 8), based on streamflow measurement April 18 when all flow was ground-water discharge from stratified drift.

Aquifer Transmissivity

The term transmissivity is used to express quantitatively the ability of aquifers to transmit water. Transmissivity is a measure of the rate at which water would flow through a vertical strip of specified width extending from the top to the bottom of the aquifer under a unit hydraulic gradient, which means a 1-foot change in water level for each foot of horizontal water movement. A unit gradient is much steeper than gradients usually observed in aquifers but serves as a standard for comparison. Techniques for analyzing potential ground-water development generally require an estimate of transmissivity. Transmissivity differs widely from place to place within most glacial-drift aquifers, however, and hence is difficult to determine precisely.

Transmissivity of the stratified drift was computed for two sections across Harford valley and one other site. Average transmissivity of the stratified drift within sections perpendicular to the valley could be computed by applying the estimated rate of ground-water underflow through those sections in the following form of Darcy's law:

$$T = Q/IW$$

where: T = Average transmissivity of stratified drift in section across valley, in ft^2/s;
Q = ground-water underflow downvalley, in ft^3/s;
I = component of head gradient downvalley, in ft/ft (presumably equal to average stream gradient where the stream is perennial; interpolated from wells tapping the principal aquifer where the stream is dry); and
W = width of saturated stratified drift, measured perpendicular to the valley, in feet.

By this method, average transmissivity was computed to be 0.35 ft^2/s in a section through the measurement station at Daisy Hollow Road, and 0.18 ft^2/s in a section through the hamlet of Harford. Transmissivity along each section may depart from the computed average value. For example, seismic data suggest a small depth to bedrock northeast of Daisy Hollow Road, and well records (table 7, at end of report) suggest a substantial thickness of fine sand or silt southwest of Route 38 near Daisy Hollow Road. If so, transmissivity may be lower than 0.35 ft^2/s near the ends of this section and correspondingly higher near the center.

Two wells west of Cotterill Lane are pumped intermittently to provide water supply for farm buildings owned by the New York State College of Agriculture (fig. 6; table 7). Pumping tests were done by the driller upon completion of these wells. Although the data obtained do not conform closely to the requirements of standard analytical methods (Ferris and others, 1962; Walton, 1962; Lohman, 1972), transmissivity at this site was estimated by averaging the results of several methods to be about 1.2 ft^2/s.

The transmissivity values obtained for the two sections and the well field were used as a guide in calibration of the digital computer model.

Aquifer Simulation and Analysis by Digital Model

Model Description

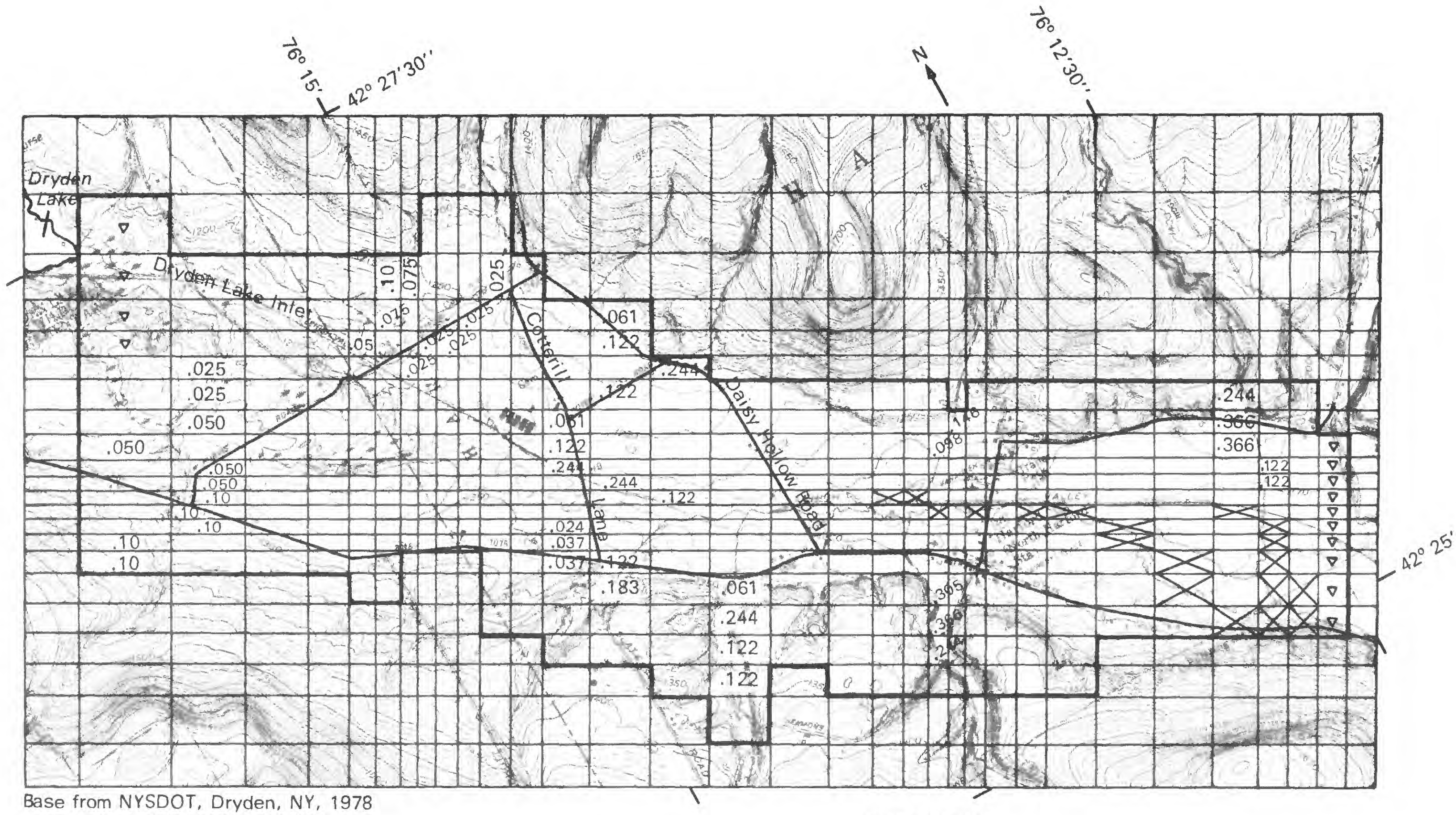
A digital model of the Harford valley was constructed to test the response of the ground-water system to hypothetical seasonal ground-water withdrawals. The model was based on the finite-difference computer program developed by Trescott and others (1976); it allows for simulation of ground-water flow in two dimensions for a confined or unconfined aquifer that may have irregular boundaries, nonuniform hydraulic properties, and nonuniform recharge in both space and time.

The program can be used to simulate aquifers of many different shapes, sizes, and properties. To apply it to conditions in Harford valley, it was necessary to first draw a grid over a map of the area to be studied, and then to specify numerical values for several properties of the flow system for each block in the grid. These properties include water level at the start of any test period, water-transmitting and water-storage properties of the aquifer, and measured or estimated rates of recharge from various sources. The program directed the computer to calculate for each block the changes in water level that would result from interaction of the specified properties during each test period. If computer-simulated water levels were much different from observed water levels, estimated values of some properties were modified until recalculation yielded closer agreement. This process of successively closer approximation to known water levels is called calibration.

The following assumptions were made to adapt the flow system in Harford valley to requirements of the program:

1. Localized perched zones of saturation (fig. 9) cause little lateral redistribution of recharge, so only the deeper or principal water table need be simulated. This assumption may be incorrect in some localities, but the effort required to construct a 2-layer model to account for these perched zones seemed unwarranted.
2. Ground-water flow in the stratified-drift aquifer is horizontal. Although downward gradients were recognized in some localities, the vertical component of flow can probably be ignored without greatly affecting the model results.
3. Recharge per unit area from precipitation is uniform over the entire model but varies seasonally.
4. Stream reaches near the valley axis downstream from Daisy Hollow Road that were flowing on August 6, 1980 (fig. 6) only gain water; they may go dry but never are a source of recharge to the aquifer.
5. All other stream reaches are ephemeral and lose water to the aquifer whenever they flow. Distribution and magnitude of seepage losses varies seasonally.
6. Ground water is discharged only by leakage to perennial streams, by underflow out of the model area, and (in hypothetical simulations) by pumping from wells. Evapotranspiration of ground water is accounted for in the calculation of recharge.
7. Water-level fluctuations in 1979-80 were small relative to aquifer thickness, so no real improvement in model accuracy would result from recomputation of transmissivity in proportion to changing saturated thickness. Sand and gravel is probably more than 100 feet thick in most places, but maximum depth and variation in permeability with depth are generally unknown. Therefore, transmissivity was specified as a single aquifer property, rather than specifying hydraulic conductivity and aquifer-base altitude, as is often done in models of unconfined aquifers.

The modeled area is depicted in figure 10. The grid consists of 22 rows and 34 columns and contains 748 blocks, the centers of which are termed "nodes." The blocks represent dimensions ranging from 250 to 1,500 feet on a



Base from NYSDOT, Dryden, NY, 1978
and Harford, NY, 1973, 1:24,000

EXPLANATION

BOUNDARY OF ACTIVE MODEL--Transmissivity is zero for all blocks outside modeled area

CONSTANT HEAD SPECIFIED TO REPRESENT MODEL BOUNDARY

CONSTANT HEAD SPECIFIED TO REPRESENT GAINING STREAM

.10 RECHARGE SPECIFIED TO REPRESENT LOSING STREAM--Number is simulated steady-state loss within block, in cubic feet per second

0 ½ 1 MILE
0 ½ 1 KILOMETER

Figure 10.--Grid configuration, boundaries, and steady-state distribution of seepage losses from streams used in aquifer model of Harford valley.

side; smaller blocks were used to better represent water levels near streams and observation wells. The resulting network is referred to as a block-centered, finite-difference grid with variable grid spacing.

Boundary Conditions

Model boundaries were chosen to represent flow conditions at the edge of the area modeled. No-flow boundaries were drawn along the valley walls at the outer margin of the stratified drift (fig. 10) because till and bedrock are several orders of magnitude less permeable than most stratified drift and transmit little ground water into Harford valley. At the west end of the model, Dryden Lake and adjacent swamps were represented by four constant-head nodes (on the assumption that ground water west of the divide drains into the lake), and a no-flow boundary was drawn south of the lake (on the assumption that ground-water flow is roughly perpendicular to the valley axis, toward the lake). The east edge of the model was represented as a constant-head boundary to simulate ground-water underflow leaving the modeled area.

Model Calibration

Steady-State Calibration.--The first step in model calibration was a steady-state calibration, in which recharge was applied at a uniform average rate throughout the period of time modeled, and the resulting simulated water levels were compared with average water levels in observation wells. Steady state is an average condition that does not occur in nature, where recharge, discharge, and water levels are always fluctuating. Nevertheless, steady-state calibration is useful in providing an opportunity to improve interpretations of the areal distribution of transmissivity and recharge before undertaking transient-state calibration, a more complex procedure in which seasonal variations in water level and recharge are simulated and storage coefficients calculated.

For steady-state calibration, flow-system properties were treated as follows:

Recharge.--A net precipitation of 31.10 inches had been calculated for the 11-month period February 26, 1979 through January 25, 1980 (table 1). This period was extended through February 25, 1980 to complete a 365-day study period, so that model simulations could begin at any time in a continuous annual cycle. Adding the 0.45 inches of precipitation measured from January 26 to February 25, 1980 (New York Climate Office, 1980) brought the annual total to 31.55 inches. Evapotranspiration from the valley floor was estimated to be 15.11 inches per year (by the method given in table 1), leaving a total recharge of 16.44 inches per year or 4.34×10^{-8} ft/s. This rate was applied uniformly over the entire modeled area.

Seepage losses from tributary streams were represented by constant specified fluxes into blocks crossed by losing stream reaches (fig. 10). Recharge from all tributaries in the original study area upvalley from the streamflow-measurement station at Daisy Hollow Road (table 1) was equivalent to a steady recharge rate of 2.42 ft^3/s. Distribution of this rate among blocks crossed by losing streams was guided by a few measurements and observations of tributary flow and was revised during calibration. Similar data were available to guide estimates of seepage losses from a few tributaries outside the original study area, but total recharge for the entire model area was not a constraint.

Discharge.--The perennial reach of the stream along the valley axis was simulated by constant-head nodes, which gained water continuously (fig. 10). Discharge also occurred by ground-water flow to constant-head nodes at both ends of the valley.

Transmissivity.--A wide range of transmissivity values was tested at various locations to determine the effect of transmissivity on model results, particularly on simulated water levels and the position of the ground-water divide. Figure 11 shows the distribution of transmissivity that gave the best results. The lowest transmissivity values (0.0075 to 0.150 ft^2/s) were found to be where the outwash was interbedded with till (fig. 5). The calculated average transmissivity of 0.18 ft^2/s in a section through Harford and 1.2 ft^2/s at a wellfield west of Cotterill Lane were confirmed by the calibration procedure. The calculated average transmissivity of 0.35 ft^2/s in a section through the streamflow-measurement station (fig. 6) was increased to an average of 0.63 ft^2/s during calibration.

Water levels.--Mean water levels for the complete year were computed for wells at sites 73, 93, and 96 (fig. 8) and were found to be similar to water levels measured on July 2, 1979. Therefore, the water levels observed on July 2, 1979 at an additional six sites were used with the three mean values to draw a water-table map assumed to represent steady-state conditions (fig. 12). Differences between the deep or principal water table in this map and the final model-simulated steady-state water table were less than 10 feet everywhere, less than 5 feet beneath most of the valley floor, and less than 3 feet at observation wells. Table 2 lists the observed and simulated values at nine observation wells. The model also placed the ground-water divide in approximately the right position. Water-level discrepancies of 5 to 10 feet occurred only near the valley walls, where data were sparse and a perched water table is probably present near streams. These results were judged sufficiently exact to proceed with a transient-state simulation.

Table 2.--Observed water levels and simulated steady-state water levels at selected wells in Harford valley.

[Fig. 12 shows water-table configuration inferred from observed levels]

New York State College of Agriculture site number	Location (figs. 6 and 12) latitude ° ' "	longitude ° ' "	Water-surface altitude (feet above sea level) Observed July 2, 1979	Simulated steady state	Difference (feet)
73	4226 40	7614 43	1202.1	1203.6	+1.5
75	4226 31	7615 00	1201.1	1203.3	+2.1
88	4226 27	7614 31	1199.9	1202.1	+2.2
93	4225 57	7614 08	1194.3	1194.0	-0.3
96	4225 50	7613 44	1188.3	1188.0	-0.3
97	4225 49	7613 44	1187.2	1187.0	-0.2
98	4225 49	7613 44	1186.4	1187.0	+0.6
99	4225 56	7613 40	1189.8	1190.1	+0.3
236	4226 18	7614 51	1199.8	1202.8	+3.0

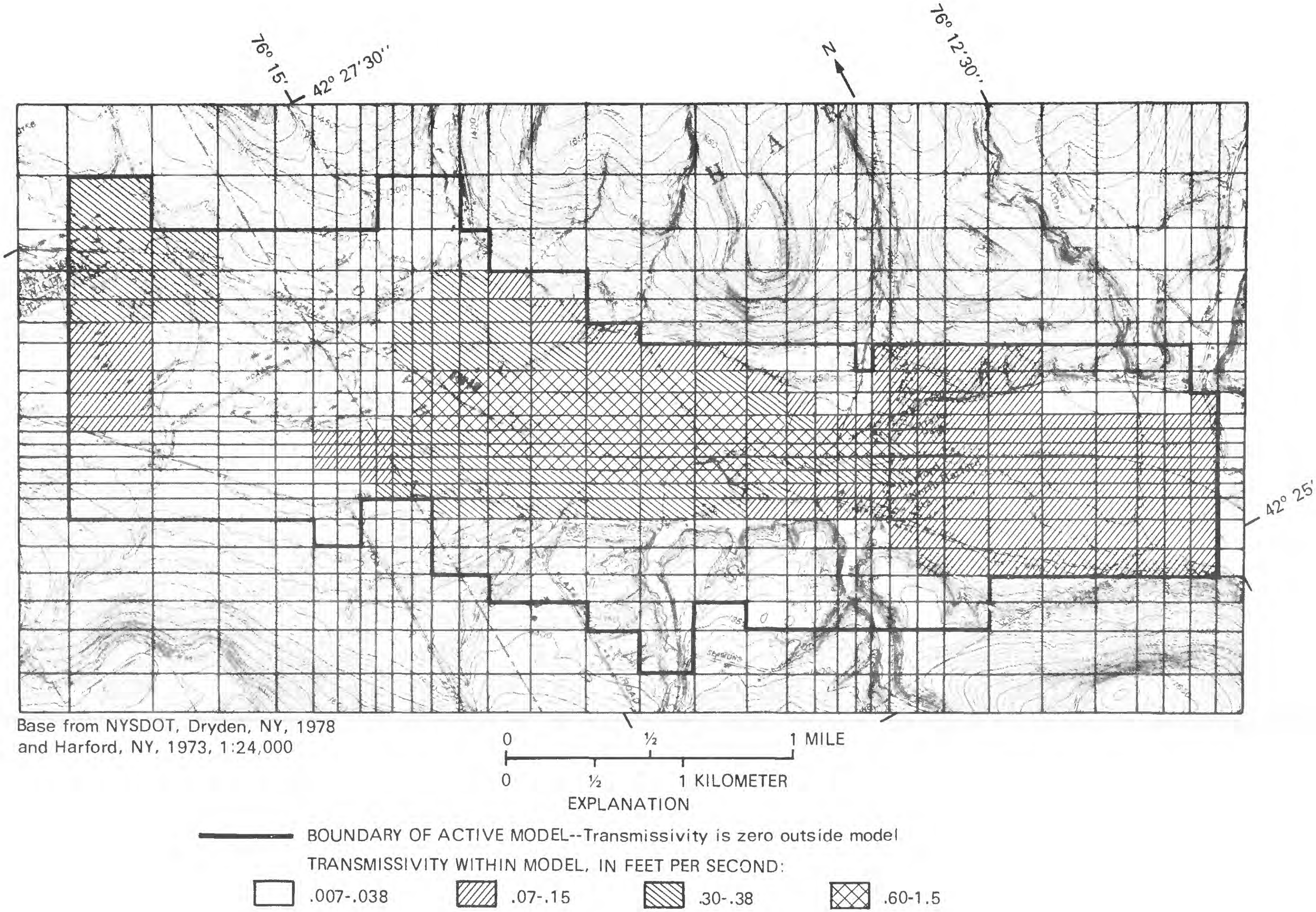
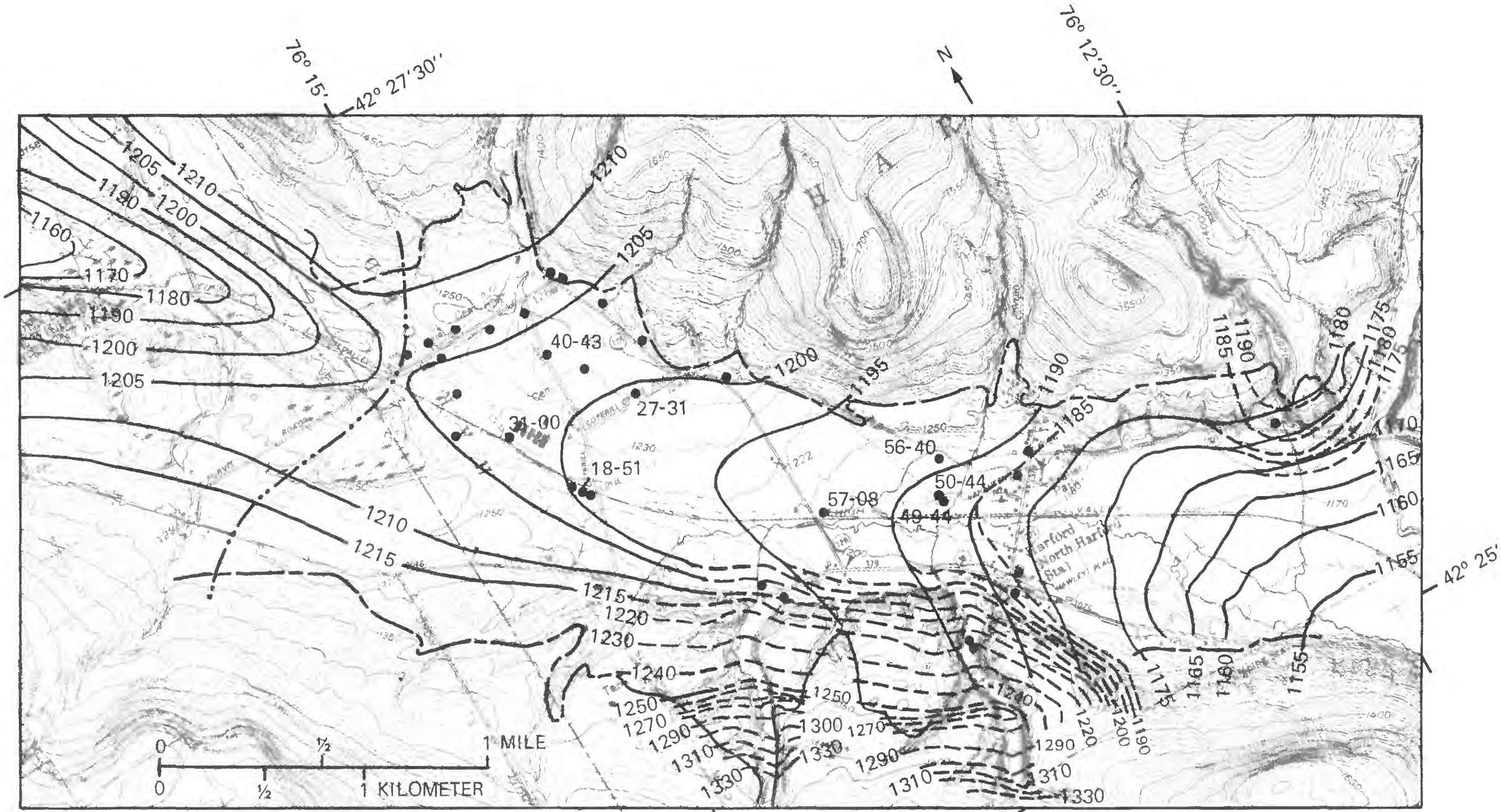


Figure 11.--Transmissivity values used in aquifer model of Harford valley.



Base from NYSDOT, Dryden, NY, 1978
and Harford, NY, 1973, 1:24,000

EXPLANATION

1180 — LINE OF EQUAL ESTIMATED WATER-TABLE ALTITUDE UNDER STEADY-STATE CONDITIONS--Solid lines represent water table in deeper or principal aquifer; dashed lines represent shallow water-table near some tributary streams. Contour interval 5 and 10 feet.

•27-31 WELL--Water level measured on one or more dates. Numbers are seconds of latitude and longitude of wells listed in table 2.

GROUND-WATER DIVIDE

BOUNDARY OF STRATIFIED DRIFT

Figure 12.--Estimated steady-state water-table configuration in Harford valley. Contours based on water-table altitude measured July 2, 1979, at wells listed in table 2 and on water-table configuration in April and September 1980 (fig. 9) for which additional control was available.

Transient-State Calibration.--The study year was divided into six time periods corresponding to observed seasonal fluctuations in water levels that reflect variations in recharge. (See fig. 7.) Table 3 lists the six periods with the areal and seepage recharge for each. Seepage for each time period was distributed among those grid blocks that were crossed by stream reaches observed or inferred to usually carry flow during that period; figures 13A and 13B show the distribution for spring and summer, respectively. The program allowed a new array of specified fluxes to be introduced in each time period and was revised so that a new areal recharge rate could be introduced at the same time. This revision allowed all six periods to be run consecutively.

Transient-state calibration was achieved by adjusting model transmissivity and storage coefficients and, to a lesser extent, distribution of stream seepage. At first, only the period from July 3 through August 31 was

Table 3.--Recharge from precipitation and streams in Harford valley during six successive time intervals.

Time interval	Precipitation (inches)[a]	Evapotranspiration (inches)[b]	Areal recharge (inches)[c]	Seepage recharge	
				(ft^3)[d]	(ft^3/s)[e]
A	B	C	D	E	F
1979					
Feb. 26-Mar. 11	3.50	0.143	3.357	2.38×10^7	19.70
Mar. 12-Apr. 26	3.29	1.051	2.239	3.96×10^7	9.965
Apr. 27-July 2	5.14	5.136	0.004	1.20×10^7	2.08
July 3 -Aug. 31	5.74	5.740	0.000	$.18 \times 10^7$	0.355
Sept. 1-Dec. 31	13.43	2.800	10.630	8.12×10^7	7.70
1980					
Jan. 1 -Feb. 25	0.45	0.253	0.207	2.25×10^7	4.645
Total	31.55	15.123	16.427	1.81×10^8	(5.74)[e]

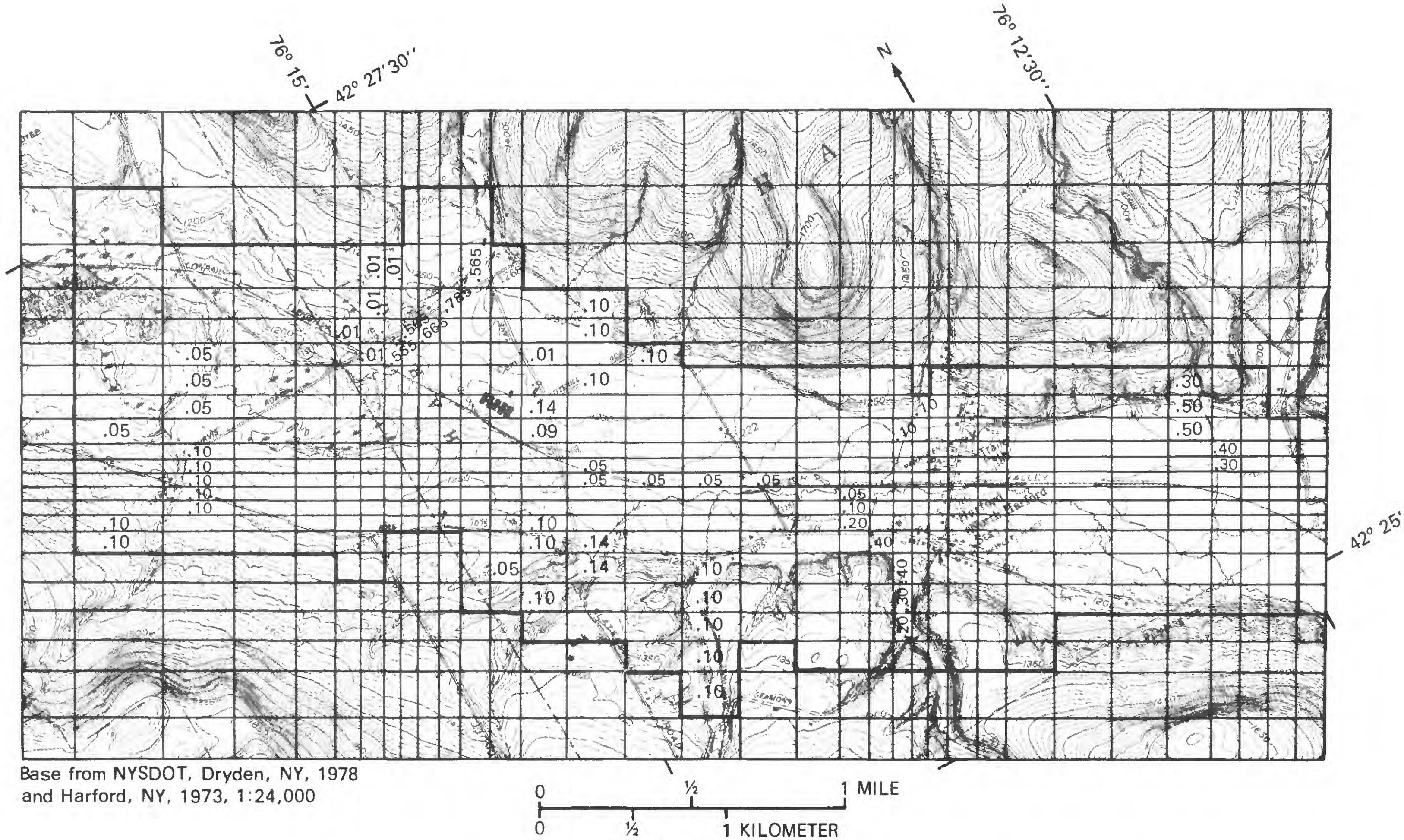
[a] Data from weighing rain gage on valley floor (New York Climate Office, 1979-80) adjusted for snow accumulation on valley floor (table 1).

[b] Annual total based on regional analysis (precipitation minus runoff equals 19.25 inches, from Ku and others, 1975) adjusted downward assuming minimal ground-water evapotranspiration in stratified drift in Harford valley (Randall, written commun., 1982). Distribution throughout the year proportional to product of mean temperature and percentage of total annual daylight for each time interval (Olmsted and Hely, 1962).

[c] Column B minus column C.

[d] For the original study area, annual total recharge from seepage (table 1) was adjusted to 0.8×10^8 ft^3 for 12 months and distributed throughout the year on a trial and error basis, weakly constrained by a few measurements of seepage loss and observations of extent of flow in tributary channels. For the rest of the model area, both annual total and seasonal distribution of seepage are estimates, similarly constrained.

[e] Column E divided by the number of seconds in each time interval; last row is not a total.

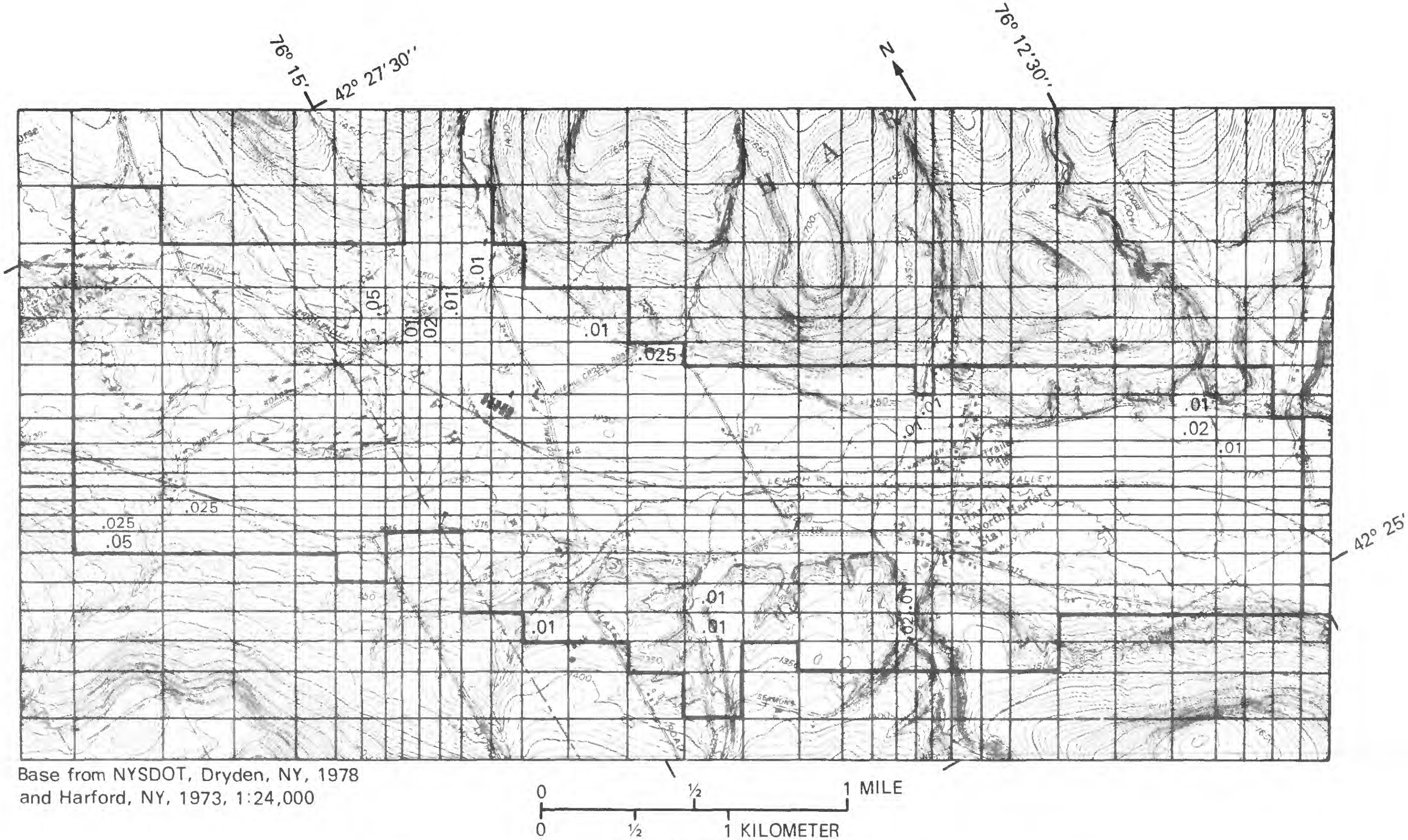


EXPLANATION

$\boxed{.05}$ RECHARGE WITHIN BLOCK FROM STREAM SEEPAGE LOSS--In cubic feet per second

BOUNDARY OF ACTIVE MODEL

Figure 13A.--Distribution recharge from stream seepage, Harford valley, March 11 through April 26.



Base from NYSDOT, Dryden, NY, 1978
and Harford, NY, 1973, 1:24,000

EXPLANATION

.05	RECHARGE WITHIN BLOCK FROM STREAM SEEPAGE LOSS--In cubic feet per second
——	BOUNDARY OF ACTIVE MODEL

Figure 13B.--Distribution recharge from stream seepage, Harford valley, July 2 through August 31.

simulated, and the model-computed steady-state water levels were used as initial water levels. (As previously explained, steady-state water levels closely resemble water levels observed July 2, 1979.) When simulated water levels for August 31 satisfactorily duplicated those observed on that date, they were used as initial water levels for a full year's simulation. To measure progress toward calibration, simulated water levels at the end of each of the six time periods listed in table 3 were compared with water levels observed at several wells. The observed water levels were read from the hydrographs in figure 8, with the qualification that peak water levels observed near March 10 and December 31 were transposed to those dates as if all wells had peaked on the same day. This shift was never more than 10 days.

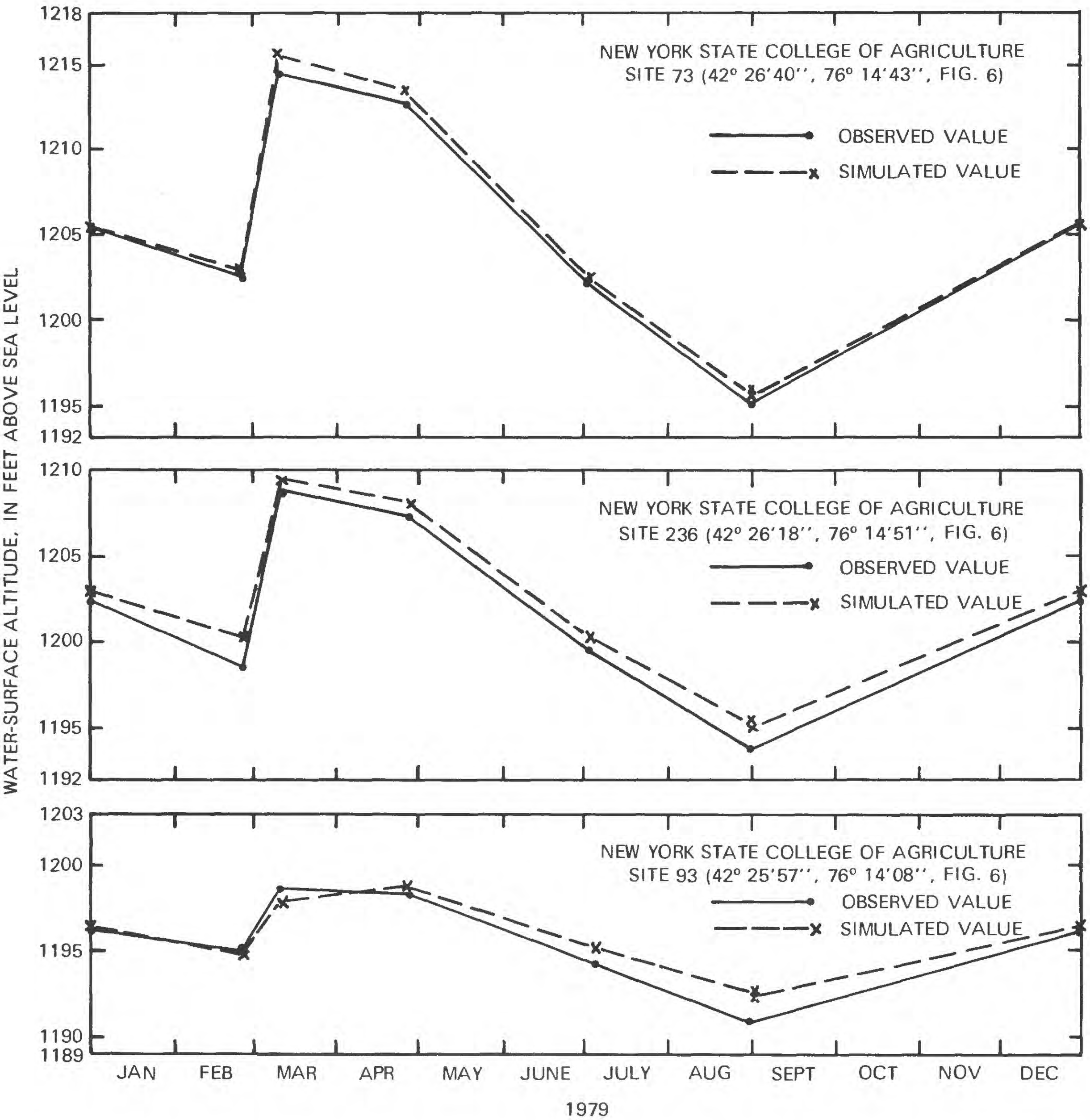


Figure 14.--Observed and simulated water levels in wells, Harford valley.

A generally close match between observed and simulated water levels was achieved, but August 31 water levels at the end of the 1-year simulation differed somewhat from the initial August 31 levels. Therefore, as a final step in calibration, a second full year's simulation was run, beginning with the final water levels from the first simulation and resulting in negligible net change over a year. Results of the second simulation are compared with observed water levels at three wells in figure 14. Recharge during a given time period was treated as a uniform average rate, so any observed water-level fluctuations within a time period could be simulated only by dividing time into shorter periods. Therefore, observed as well as simulated water levels in fig. 14 are drawn as straight lines across each time period. The difference between observed and simulated water levels at the end of each period does not exceed 1.7 feet, and is generally less than 0.8 foot. The simulated water-table configurations on April 26 and August 31 are shown in figs. 15A and 15B; comparison with figures 9A and 9B indicates that the simulated ground-water divide is generally within 600 feet of the inferred actual ground-water divide in the spring and generally within 1,500 feet of the inferred divide in late summer.

The calibration procedure showed that the valley-floor area with extensive till deposits (fig. 4) and the area lacking till have very different storage coefficients. The former has a storage coefficient of 0.02, which is characteristic of material with low permeability, whereas the area lacking a till layer has a storage coefficient of 0.20, characteristic of sand and gravel. These values realistically reflect the geology of each area.

Simulated Effect of Seasonal Ground-Water Withdrawals on Water Levels and Streamflow

Once the model was calibrated so that it could duplicate the water table's response to natural recharge and hydrologic conditions of 1979-80, it was used to predict the effects that large seasonal ground-water withdrawals would have on water levels near Harford and on streamflow downvalley. Any new discharge must eventually be balanced by some compensating decrease in discharge or increase in recharge. In a through valley such as at Harford, the following effects could be expected, as illustrated in figure 3:

1. During the period of seasonal use, much of the water pumped would be withdrawn from storage in the aquifer, and water levels would decline. (The area of decline is termed a cone of depression because of its shape.)
2. As the cone of depression became larger and deeper, eventually it would extend beneath the perennial stream along the valley axis. This would cause discharge to the stream to decrease and might cause upper reaches of the stream to go dry.
3. After pumping ceased, discharge to the perennial stream would remain subnormal until the cone of depression refilled.
4. Recharge from upland runoff should increase. Given the rainfall distribution in 1979-80, little increase could be expected during the fall and winter because nearly all upland runoff infiltrated under natural conditions. During the spring, however, the large seepage losses observed through early March under natural conditions (fig. 7) would continue longer, because the aquifer would not be refilled to stream grade as quickly.

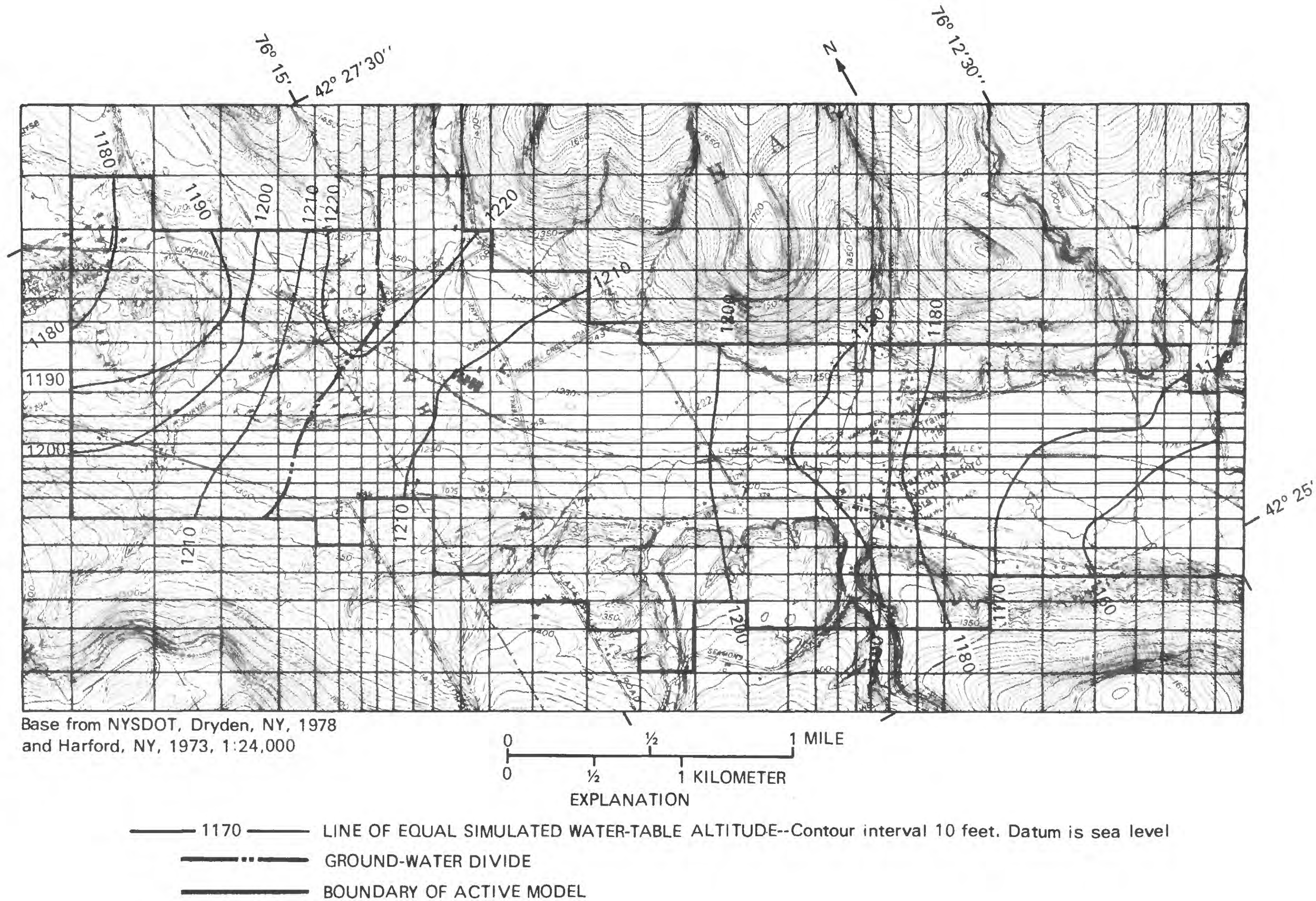
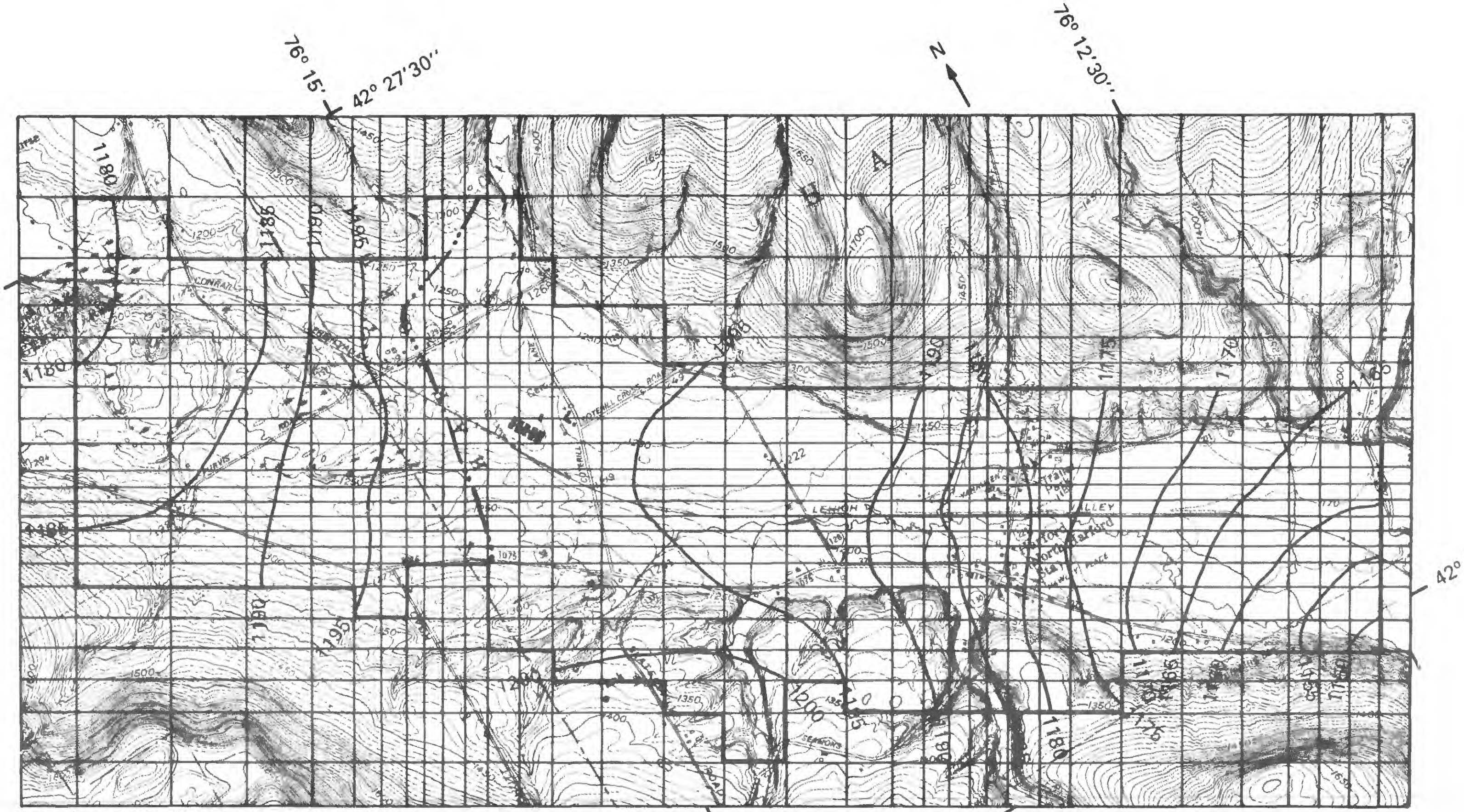


Figure 15A.--Simulated water levels in Harford valley, April 26, 1979.



Base from NYSDOT, Dryden, NY, 1978
and Harford, NY, 1973, 1:24,000

0 ½ 1 MILE
0 ½ 1 KILOMETER

EXPLANATION

—— 1170 —— LINE OF EQUAL SIMULATED WATER-TABLE ALTITUDE--Contour interval 10 feet. Datum is sea level

—— • • —— GROUND-WATER DIVIDE

———— BOUNDARY OF ACTIVE MODEL

Figure 15B.--Simulated water levels in Harford valley, August 31, 1979.

The model can predict effects 1-3 (p. 37) with reasonable accuracy but not effect 4 because recharge from stream seepage must be specified by the user of this model. (Models could be developed in which seepage is calculated by the computer as a function of streamflow, head difference between stream and water table, and(or) other variables, but data required to calibrate such models were not obtained in 1979-80.) For this report, the rates of stream seepage for March 12 through April 26 were multiplied by 1.75 in the central part of the model; by 1.25 near and beyond Daisy Hollow Brook, where a till layer may limit seepage and water-level declines were modest; and by 1.0 southeast of Harford, where water-level declines were negligible. Under these assumptions, the net increase in recharge due to ground-water development would be 1.6×10^7 ft^3.

As during calibration, the perennial-stream reach along the valley axis was simulated by specifying constant heads equal to stream altitude in blocks along the stream. For predictive transient simulations, however, it was also necessary to allow the upstream end of the gaining reach to migrate downvalley when the water table declined during the summer as a result of the combined effects of underflow and pumping. The program was revised to cause any constant-head block to become an active block as soon as it began to lose water to adjacent blocks, thereby simulating the progressive drying up of the stream as nearby water levels declined below stream grade. To simulate the upvalley extension of ground-water discharge during periods of rising water levels, it was necessary to interrupt the simulation and reestablish constant-head nodes.

For this report, the effects of two alternative strategies for seasonal use of the aquifer were tested by simulating withdrawals between Harford and the ground-water divide during July and August. The two strategies were:

A. Withdraw in one summer the maximum volume obtainable in an efficient manner from the ground-water reservoir without regard to residual effects beyond that summer or the number of years before full recovery takes place; and

B. Withdraw in one summer only the amount that would be replaced before the following summer so that the same withdrawal could be made each year.

To test the first strategy (maximum seasonal withdrawal), only the period from July 3 through August 31 was simulated. Hypothetical wells were postulated in 20 blocks throughout the area of highest transmissivity and pumped at varying rates. Results (table 4) suggest that reductions in streamflow downvalley during the summer would be only a small fraction of the seasonal withdrawal. If production wells end at the same depth as the only screened large-yield wells in the model area in 1980, about 65 feet below the July water table, a maximum withdrawal of about 17 Mgal/d for 2 months seems plausible. If production wells could be screened at multiple depths in an aquifer at least 200 feet thick, and if the effect of large withdrawals on domestic wells in the valley were not a consideration, infrequent seasonal withdrawals of much more than 17 Mgal/d might be plausible.

To test the second strategy (regular seasonal withdrawals), the entire year was simulated. Pumping was again limited to July and August, this time in four blocks along the valley axis. After pumping ceased, simulated water levels rose gradually, and, as soon as they had risen to stream grade in any block along the valley axis, the constant-head function in that block was reinstated. Several hypothetical rates of withdrawal were tested, and in each test, the water levels at the start of the 2-month pumping period were compared with water levels 12 months later. A total withdrawal of 10.8 Mgal/d during July and August was the largest rate at which the water table would return (within 0.4 feet) to its initial level throughout the area upvalley from Harford, where transmissivity exceeds 0.3 ft^2/s (fig. 11). The hypothetical wells pumped a total of 8.7×10^7 ft^3 (648 Mgal). According to the model, this withdrawal was balanced by the following changes:

1.	Reduction in downvalley flow during the 2 months of seasonal withdrawal	1.2×10^7 ft^3
2.	Reduction in downvalley flow after the 2 months of seasonal withdrawal	5.6×10^7 ft^3
3.	Increased recharge from stream seepage in the spring following withdrawal	1.6×10^7 ft^3
4.	Residual drawdown at the end of 12 months	0.3×10^7 ft^3

The success of this strategy of making seasonal withdrawal equal to annual replenishment so as to repeat nearly the same water levels each year depends on the volume of additional recharge from stream seepage that results each spring from the lowered water table. As previously explained, this volume (item 3 above) is an estimate and should be confirmed by field studies in any valley where development is contemplated. Furthermore, the entire model simulation is based on a recharge value determined for a single 12-month period that was probably somewhat dryer than normal. Comparison with long-term records of precipitation at Cortland indicate that 1 year in 4 would have less precipitation. Comparison with long-term records of runoff indicates that

Table 4.--Effect of hypothetical seasonal pumpage in Harford valley as simulated by digital model.

Pumping strategy (see p. 40)	Total pumping rate (Mgal/d)	Maximum drawdown July 3 to August 31 (feet)[a]: From digital model	Maximum drawdown July 3 to August 31 (feet)[a]: Adjusted for reduced transmissivity[b]	Changes in streamflow on August 31 due to pumping: Distance that start of streamflow shifted downvalley due to pumping (ft)	Changes in streamflow on August 31 due to pumping: Reduction in streamflow (Mgal/d)
First	8	24.0	25.4	1900	1.14
	12	33.5	36.3	2400	1.20
	16	43.5	48.2	2600	1.40
	20	53.3	60.4	2900	1.44
	24	62.6	72.4	3100	1.48
	28	72.2	85.2	3300	1.52
	32	82.5	99.5	3700	1.59
	40	102.	128.	4200	1.62
Second	10.8	31.0	33.4	1900	1.17

a Drawdown is average over area of block; drawdown at production wells of 24-inch diameter would be about 5 percent greater.

b Drawdown increased by an amount $S^2/2m$ (Ferris and others, 1962, p. 102), where S is drawdown from model, and m is aquifer thickness (poorly known but taken as 200 feet for this computation).

1 year in 2 would have less runoff (fig. 16). Thus, seasonal pumpage of 10.8 Mgal/d for about 2 months in Harford valley should result in a small net decline in water level in dry years but not over the long term. Recharge from upland runoff during the spring freshet and other major storms could probably be increased by constructing multiple channels or seepage basins along ephemeral streams.

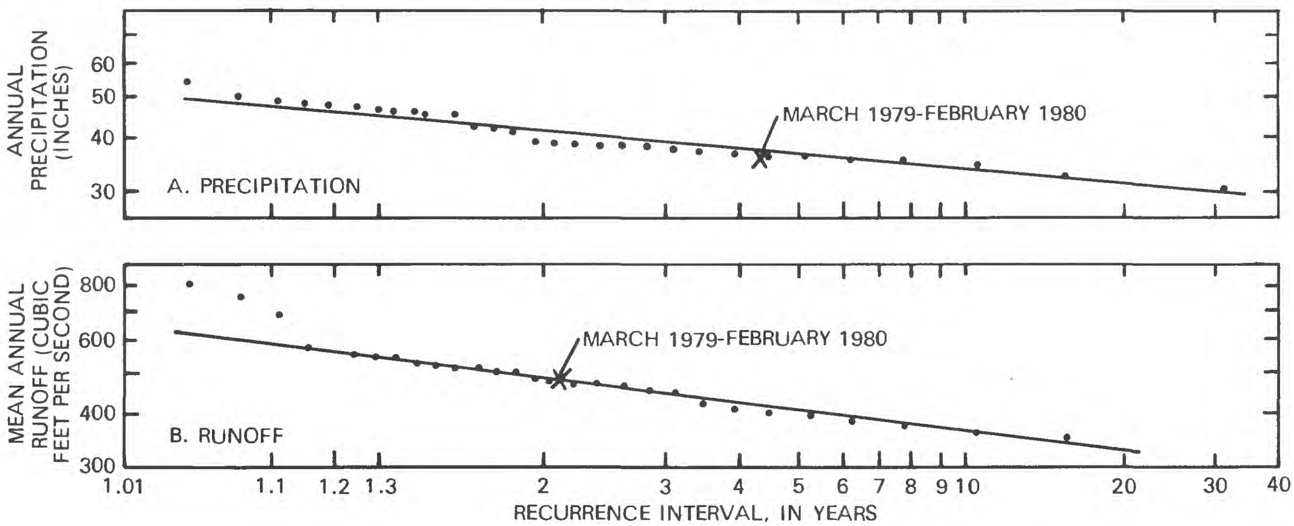


Figure 16.--Frequency distribution of precipitation and runoff near Cortland, 1951-80. A. Precipitation at Cortland. (National Weather Service, 1950-80.) B. Runoff, Tioughnioga River at Cortland. (U.S. Geological Survey, 1951-80.)

A different test simulation was used to evaluate the effects of prolonged withdrawal during drought. A total of 5.4 Mgal/d was withdrawn from four wells between the divide and Harford for 150 days beginning on July 2. Recharge from precipitation was nil, and recharge from seepage minimal (4 percent of pumpage), which approximates what could be expected in an unusually dry year. Ground-water discharge to constant-head stream nodes was determined at 30-day intervals and subtracted from simulated discharge under nonpumping conditions for the same period; the difference represents the reduction in streamflow due to the simulated withdrawal. The test was repeated at a withdrawal rate of 10.8 Mgal/d. The results of these tests are compared in figure 17 with streamflow depletion under similar drought conditions in typical river valleys, as reported by Paul Seaber (U.S. Geological Survey, written commun., 1967). Seaber analyzed several typical valley reaches, two of which are considered in figure 17. In each reach a line of wells was postulated near the valley wall, as far from the master stream as feasible to minimize streamflow depletion. The percentage of pumpage derived from the river was calculated for each reach by standard analytical methods (Bentall, 1963, p. C106-9; Ferris and others, 1962, p. 144-166).

Differences among the curves in figure 17 may be caused in part by differences in withdrawal rates, aquifer transmissivity, and analytical methods but are largely a result of the contrast in configuration of the stream with respect to the aquifer. In typical valleys, streamflow depletion as a percentage of pumping increases with time and eventually equals the pumping rate. In through valleys, streamflow depletion is always a small percentage of the pumping rate and, after an initial period of adjustment, decreases steadily with time as the stream dries up and recedes away from the well field. Much larger withdrawals are possible from typical valleys, however, because induced recharge from the stream prevents excessive drawdowns, and the length of the reach can ordinarily be increased.

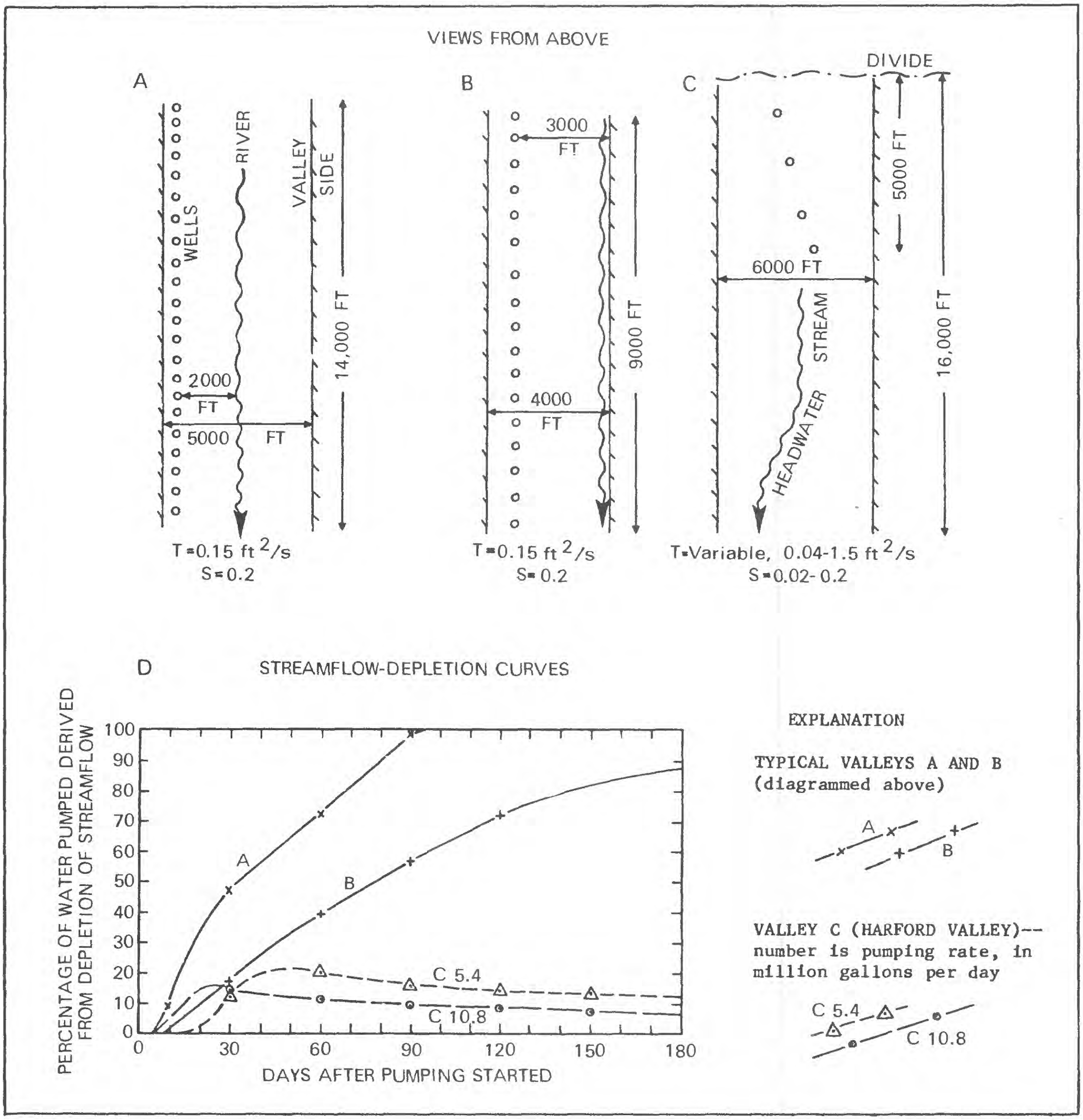


Figure 17.--Streamflow depletion due to ground-water pumping in through valleys compared to that in typical valleys during prolonged drought: A, B. Arrangement of stream and wells postulated by Seaber (U.S. Geological Survey, written commun., 1967) in two typical valley reaches. C. Arrangement of stream and wells postulated in Harford through valley. D. Streamflow depletion as a function of time and pumping rate. Water not derived from streamflow depletion is derived from storage.

GEOHYDROLOGIC APPRAISALS OF THROUGH VALLEYS IN THE SUSQUEHANNA RIVER BASIN

Topographic maps reveal at least 29 flat-floored valleys on the perimeter of the Susquehanna River basin in New York, each of which could be classified as a through valley. During this study, 18 of these valleys (fig. 2) were examined and brief geohydrologic appraisals prepared. The remaining 11 valleys were not examined for a variety of reasons. Two were classified as "separated valleys" because each abuts a large river at one end; they were also subjects of concurrent studies (Reynolds, 1987; VanAlstyne and others, 1982). One was included in two recent areal geohydrologic appraisals (Buller, 1978; Miller and others, 1981). Some lacked roads and were virtually uninhabited and thus offered little opportunity to obtain subsurface information. Some were very small, largely covered by swamps, or crossed by sizeable upland tributaries close to the divide and hence seemed to have less potential for seasonal ground-water development than the valleys selected for appraisal.

Records of a few wells and test borings were available from most of the valleys selected (Randall, 1972), as were small-scale regional interpretations of aquifer geometry and well yield (Hollyday, 1969; MacNish and Randall, 1982). County soils maps provided information on surficial geology, and reconnaissance maps of some areas by R. G. LaFleur (U.S. Geological Survey, written commun., 1967) showed the boundary between stratified drift and till. In 1980-82, records of more wells in these valleys were obtained from property owners, well drillers, and field measurements. Excavations were examined, as were samples of unconsolidated sediments obtained through a hollow-stem power auger from depths as great as 100 feet. These data were used to compile a map of surficial geology, construct geologic sections, interpret aquifer dimensions and potential well yield, and in some valleys to determine the configuration of the water table. The well records have been entered into the U.S. Geological Survey's WATSTORE computer storage and are summarized in table 7 (at end of report). The well-numbering system is also described in table 7.

The geohydrologic appraisals that follow were written largely by R. M. Waller. T. J. Holecek collected most of the new data and prepared preliminary interpretations for some valleys.

Similarities and Contrasts Among the Valleys Appraised

Types of Unconsolidated Deposits

Deglaciation of the through valleys left three general types of unconsolidated deposits overlying the bedrock in each valley. The three types are unstratified drift, stratified drift, and alluvial deposits.

Unstratified drift consists of till, which is a homogenous mixture of silt, clay, stones of various sizes, and sand. Till is the principal unconsolidated deposit on the uplands and valley sides and also occurs locally beneath the valley floors. The till is poorly permeable. Some areas are mapped herein as ablation moraine, which consists largely of till but commonly contains minor lenses of stratified drift.

Stratified drift consists of layered sediments deposited by glacial meltwater. Those deposited against or atop the melting ice are termed ice-contact deposits and are classified as kame terraces or undifferentiated ice-contact deposits on maps in this report. Kame terraces have relatively level upper surfaces and are distributed along the base of the valley wall. Undifferentiated ice-contact deposits have irregular upper surfaces (because of collapse as buried ice melted) and locally grade into kame terraces. Both types consist of gravel, sand, and silt, transmit water readily, and will permit large well yields, but the undifferentiated ice-contact deposits are generally siltier and less well sorted.

Stratified drift deposited away from the ice front consists of lacustrine deposits and outwash. The lacustrine deposits include clay, silt, and fine sand that settled on the bottoms of proglacial lakes that formed between ice to the north and previously deposited sediment downvalley. The outwash consists of coarse sand and pebble gravel that was deposited as deltas into the proglacial lakes or as channel deposits along proglacial meltwater streams. Outwash forms gently sloping surfaces that commonly occupy a large fraction of valley width. Ice-contact deposits may grade downvalley into outwash, and lacustrine deposits are commonly capped by outwash, although some lacustrine deposits accumulated in depressions that formed after outwash deposition ceased.

Alluvial deposits, which include alluvial fans and flood-plain deposits, were laid down in every through valley by modern streams after ice and meltwater had disappeared. The alluvial fans are fan-shaped wedges of silty gravel built by tributary streams atop the stratified drift in the valleys. Flood-plain deposits border every stream but on the maps in this report they are shown only in broad flat parts of the valleys where they are extensive. They consist of a few feet of silt and fine sand commonly overlying channel gravel. Organic muck and peat deposits are mapped with flood-plain deposits even though many of them developed in postglacial lakes that received little or no sediment from streams.

Distribution of Lacustrine Deposits and Till

The reconnaissance study of through valleys revealed two consistent and complementary geologic patterns. The first has to do with the distribution of lacustrine deposits, the second with the distribution of till. Extensive lacustrine deposits are found in the eastern and westernmost through valleys, where large lakes apparently developed after an initial period in which ice-contact deposits formed amid abundant stagnant ice. Clay, silt, and very fine sand settled on the lake bottoms; coarse sand and gravel was trapped in ponds to the north for a time but eventually prograded southward across the lake-bottom sediment as deltaic or fluvial outwash. The central valleys, by contrast, show little evidence of an extensive lake south of the present divide; although lenses of lake deposits occur here and there, the supply of coarse sediment generally kept pace with melting of the ice. The distribution of lacustrine deposits among the valleys identified in figure 2 is as follows:

Valleys containing extensive lacustrine deposits beneath surficial outwash:

East: Bridgewater Flats, Madison-Bouckville, Pinewoods, Fabius, Sheds (lacustrine but no outwash), Tully (lacustrine several miles south of divide), Schenevus Creek (lacustrine south of shallow headwater reach)

West: Bath, North Cohocton(?), Wayland, Burns

Valleys not containing extensive lacustrine deposits: Preble dry valley, Harford, Caroline, Willseyville Creek, Pony Hollow, Beaver Dams

Valleys in which information is insufficient for classification: Tully (near divide; outwash very thick), Labrador Pond, Alpine.

Several through valleys, mostly along the central part of the basin perimeter, have a layer of till near the top of the valley fill close to the divide. At Harford, till was recognized beneath a few feet of gravel in several test holes and in streambank exposures; its known extent is shown in figure 4. In Preble dry valley (fig. 26A), soils maps suggest surficial till north of the divide. At Tully, sandy-silty till was observed overlying gravel at the corner of Gatehouse Road and Route 80, at the very head of the south-sloping outwash, and in other exposures downslope to the north (Andrews and Jordan, 1978, p. 327; D. E. Andrews, Syracuse University, oral commun., 1978). Muller (1966) suggested an ice readvance to perhaps 4 miles south of Tully on the basis of topographic evidence. In the east limb of the Fabius valley, in Pinewoods valley, and in North Cohocton valley, soils maps and (or) numerous exposures and auger holes suggest that a till layer several feet thick mantles the valley floor near the divide (figs. 20, 22, 32). In several other valleys, the surface of the stratified drift near the divide is dotted with knobs and kettles that indicate buried abundant ice when meltwater flow ceased; the ice might have resulted from a late readvance of the glacier.

Exposures and well records suggest that a few hundred feet of drift, all or mostly stratified, underlie these till layers and hummocky areas. If so, the ice sheet must have left great thicknesses of meltwater deposits in these valleys during its initial retreat, readvanced briefly to or just beyond the divide in at least the central part of the basin perimeter, then dissipated without leaving more than a trace of outwash.

The till layer can be hydrologically significant. At Harford, for example, it probably limits recharge from some tributaries and reduces the storage capacity of the valley fill near and north of the divide. Where observed at Fabius, it is above the water table and may limit recharge.

The explanation for the apparent complementary distribution of till and lacustrine deposits in through valleys probably lies in the dynamics of ice flow during deglaciation. The central valleys lie south of the Lake Ontario basin and deep within the lowest part of the Applachian Plateau, where obstructions to ice flow were less than to the east and west. Furthermore, most are at the south end of the Finger Lakes troughs, where ice flow was especially vigorous, as evidenced by the deep incision of these valleys (von Engeln, 1961; Coates, 1966a). Ridge tops near the eastern and western valleys are slightly higher, and the eastern valleys lie in the lee of the

Adirondack Mountains and Tug Hill. Perhaps the ice in these areas may have been more sensitive to climatic cycles and thus retreated farther north during warm years, allowing large proglacial lakes to form in and north of the through valleys.

Summary of Geohydrologic Appraisals

The 19 through valleys identified in figure 2 differ in their potential as sources of seasonal ground-water supplies. Table 5 summarizes the geohydrologic appraisals of these valleys and provides a convenient means of comparing them. As explained in the section "seasonal ground-water development" (p. 7-10), the principal geohydrologic factors influencing potential seasonal yield are recharge, aquifer properties, and interference with other uses of water. These factors are treated in table 5 as follows:

1. Recharge.--Recharge to surficial aquifers is directly proportional to area of stratified drift, plus area of bordering hillsides that drain onto the stratified drift, plus some fraction of the discharge or area of upland basins that drain to tributary streams crossing the stratified drift. Table 5 lists the area of stratified drift and the area of hillsides plus upland tributary basins for each through valley. In general, the larger these areas, the greater the recharge. The increase in recharge that could be expected as a result of seasonal development cannot be estimated without further studies. Lowering the water table seasonally would not increase recharge from precipitation, nearly all of which infiltrates already, but should increase the time or channel length in which large seepage losses from tributaries occur. In general, therefore, through valleys in which the ratio of bordering upland to aquifer exceeds 2:1 are the most likely to be refilled each year by increased recharge.

2. Aquifer thickness.--Aquifer properties that control the rate of withdrawal from each well and from the aquifer are transmissivity (permeability times thickness) and storage (percent drainable pore space times area and thickness). Thick aquifers have more water in storage and can be developed more efficiently with fewer wells than thin aquifers. In table 5, saturated thickness of surficial aquifers is indicated as either greater or less than 40 feet; significant buried aquifers are indicated by footnotes. Areas where the saturated thickness of the uppermost sand and gravel layers exceeds 40 feet should be suitable for wells yielding several hundred to a few thousand gallons per minute (Hollyday, 1969), although the highest yields can be obtained only where the sand and gravel is clean and permeable as well as thick.

3. Effect on other water use.--The lowered water table that accompanies seasonal ground-water withdrawal would reduce the yield of existing wells, dry up streams and wetlands, curtail subirrigation of crops, and lower the stage in lakes within the developed area. Reductions in well yield would be greatest among shallow wells and might require that the wells be deepened or an alternative water supply be obtained. The effect on wetlands might be considered a disadvantage (from the viewpoint of the wetland ecosystem) or an advantage (in reducing the loss of ground water to the atmosphere by evapotranspiration). Every through valley contained

Table 5.--Summary of geohydrologic appraisals of through valleys.

[Locations are shown in fig. 2.]

Through valley (listed east to west)	Area of stratified drift (square miles) [a]	Ratio of area of bordering upland to area of stratified drift [b]	Saturated thickness of aquifer exceeds 40 feet	Present water uses that may be curtailed by lower water table
Schenevus Creek				
Upstream from Brooker Hollow	0.2	2.9 : 1	No	--
Brooker Hollow to Hudson Lake [c]	1.1	14.2 : 1	Yes	Many domestic wells
Bridgewater Flats	5.2	2.3 : 1	No	--
Madison-Bouckville [d]	2.3 (4.7)	1.5 : 1 (2.3 : 1)	No	Many domestic wells Canal that diverts runoff from this and Pinewoods valley north across topographic divide Recreational lakes
Pinewoods	4.7	2.3 : 1	Part [e]	Wetland, recreational lakes
Sheds	0.8	0.6 : 1	No(?)	Wetland
Fabius	5.1	1.3 : 1	Yes	Wetland (north limb)
Labrador Pond	2.0	3.8 : 1	Yes(?)	Wetland (State nature preserve)
Tully [f]	9.1	1.6 : 1	Yes	Recreational lakes Many domestic wells
Preble dry valley	1.7	1.8 : 1	Yes	--
Harford	2.8	2.2 : 1	Yes	Many domestic wells
Caroline	1.1	1.5 : 1	Yes	Wetland
Willseyville Creek	2.8	2.0 : 1	No(?)	--
Pony Hollow	1.0	12.9 : 1	Yes	--
Alpine [g]	0.8	7.9 : 1	No	Wetland, many domestic wells
Beaver Dams	1.6	3.7 : 1	Yes	Many domestic wells
Bath	2.3	0.8 : 1	Yes [h]	Springs north of divide used by fish hatchery
North Cohocton	2.0	0.7 : 1	No	--
Wayland	3.1	1.0 : 1	No(?)	Wetlands, municipal well field Municipal well field
Burns	7.8	0.8 : 1	No(?)	Intensive agriculture on ditched subirrigated muckland

a Measured between topographic divide and downstream end of headwater reach discussed in text. Small areas of stratified drift immediately north of the divide could be considered part of the same aquifer in most valleys, but were not included.

b Upland area includes hillsides sloping directly toward the stratified drift and catchments of small tributaries that drain across the stratified drift.

c Includes catchment of Oak Creek, 10 square miles of upland.

d Values in parentheses also include areas drained by canal from topographic divide north to Solsville, where canal enters Oriskany Creek.

e Also widespread buried aquifer.

f Not described in this report; see Buller (1978), Miller and others (1981).

g Area tributary to Cayuta Creek upstream from Alpine ignored.

h Buried aquifer in adjacent reach of Cohocton valley.

at least a few domestic wells and a few small wetlands in 1982; valleys with an abundance of either are cited in table 5 along with other uses of water.

Valleys Appraised

Information on the surficial geology and hydrology of individual through valleys is given on the following pages. The valleys are described from east to west. Locations are shown in figure 2 (p. 6).

Schenevus Creek

Valley setting.--The headwater reach of Schenevus Creek valley in Otsego County (fig. 18) is not a typical through valley. The valley floor is only 0.1 mile wide within a mile of the divide, and the valley walls in the narrow section are unusually steep and high. The valley floor broadens to 0.4 mile wide near East Worcester, where Schenevus Creek is joined by Brooker Hollow and Oak Creek. Although glacial ice overtopped the entire region, the lack of a broad valley floor at the divide suggests that the flow of ice and(or) meltwater through this highest and easternmost of the through valleys must have been less vigorous or less persistent than in other through valleys.

Surficial geology.--Glacial deposits in the Schenevus Creek valley consist of till, stratified drift, and alluvium. A silty, stony till mantles the bedrock on the slopes. Stratified drift underlies the valley floor. Terraces of poorly sorted ablation moraine or ice-contact deposits overlie the lower slopes on both sides of the valley (fig. 18). These terraces are on rock-cut benches in the upper half mile of the valley; consequently, the deposits are thin there. Between the terraces in this reach is a narrow "channel" floored by deposits of silt and gravel that range in thickness from an estimated average of 15 feet at the northeastern end of the valley (based on seismic profiles and highway test borings) to more than 45 feet in well 46-34 at the mouth of Brooker Hollow. The upper layers are alluvial fan or flood-plain deposits but overlie stratified drift. The narrow "channel" probably originated from meltwater erosion as the ice tongue wasted away. The absence of outwash suggests that meltwater from the area north of the divide was diverted to other, lower spillways (perhaps Cherry Valley Creek to the west and(or) Catskill Creek to the southeast) soon after ice in the headwater reach of Schenevus Creek melted.

Tributaries from Brooker Hollow downvalley have deposited large alluvial fans, but the underlying kame and kame-terrace deposits constitute most of the valley fill. Two deep wells southwest of East Worcester (fig. 18) were drilled through 167 and 180 feet of unconsolidated material; the records (table 7) suggest that 100 feet or more of fine sand and silt underlies perhaps 45 feet of saturated silty sand and gravel.

Hydrology.--The aquifer system is small in the reach upstream from Brooker Hollow. Well data (fig. 18 and table 7) show that the ice-contact deposits on the terraces are commonly dry and less than 30 feet thick. The deposits beneath the narrow flood plains are saturated but thinner. No wells draw water from any of these deposits. The steep till-covered valley walls in this reach have no stream system. Surface runoff from the valley walls and precipitation on the valley floor are the only sources of recharge to the flood-plain deposits.

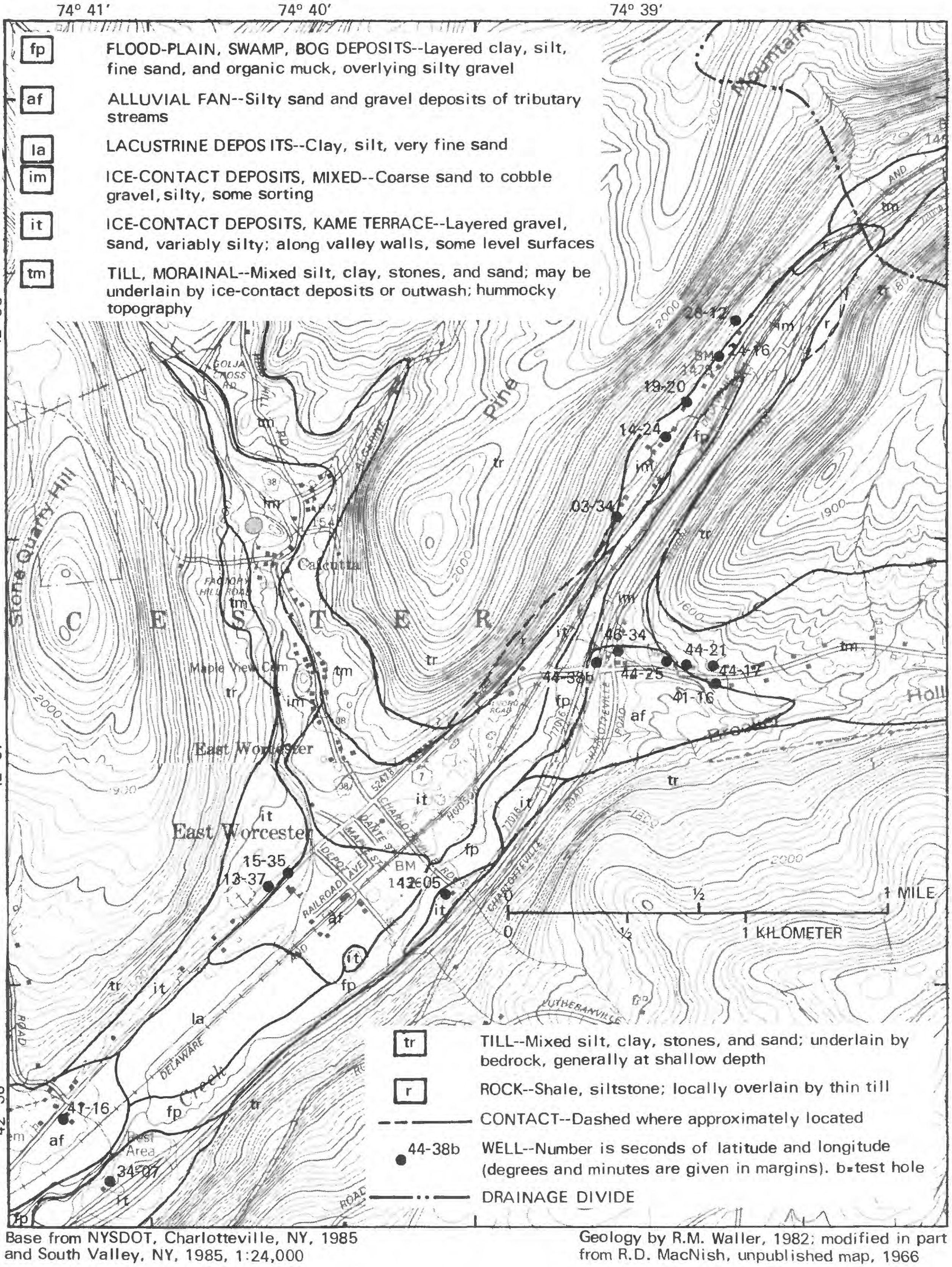


Figure 18.--Reconnaissance map of Schenevus Creek valley showing surficial geology and well and test-hole locations.

Downstream from Brooker Hollow, the ice-contact deposits are thicker and are probably saturated to stream level on the valley floor and to within 15 feet of land surface elsewhere. Perennial flow in Schenevus Creek begins about 1.5 miles from the drainage divide, just below the mouth of Brooker Hollow. Seepage from Brooker Hollow and Oak Creek is undoubtedly a significant source of ground-water recharge in this reach. Both tributaries drain larger basins than the main stem of Schenevus Creek. Both went dry in September 1982 as a result of seepage losses where they crossed the valley fill, although presumably both are perennial where incised in till and bedrock in the upland (Ku and others, 1975, p. 82).

Evaluation.--Stratified drift in the headwater reach of Schenevus Creek valley between the divide and Brooker Hollow is narrow, thin, silty, largely unsaturated, and unlikely to yield significant seasonal water supplies.

Stratified-drift thickness increases downvalley from Brooker Hollow, and moderately permeable sand and gravel seem widespread at shallow depth, although none of the wells listed in table 7 obtain a large yield. Large seasonal withdrawals between Brooker Hollow and Hudson Lake would induce infiltration from Oak Creek, however, leaving the creek dry for longer periods than under natural conditions, and would eliminate the small natural ground-water discharge to Schenevus Creek. Such withdrawals might also reduce yields of some wells at East Worcester.

Bridgewater Flats

Valley setting.--Bridgewater Flats, in southeastern Oneida County (figs. 2, 19), is a typical through valley. It is about 4 miles long and 1 mile wide at the divide but narrows southward to 0.5 mile wide near the village of Bridgewater. The valley floor slopes to the south, gradually descending about 60 feet from the divide to Bridgewater. It also has a slight slope to the east, where it has been incised by the West Branch Unadilla River. Drainage north of the divide is to Sauquoit Creek in the Mohawk River basin.

Surficial geology.--The level floor of Bridgewater Flats constitutes a valley train extending from the divide south nearly to Bridgewater village. Records of wells (table 7), concentrated near Route 8, suggest that a wedge of surficial outwash thins southward from at least 45 feet in thickness near the divide to 15 or 20 feet a half-mile north of Bridgewater. It overlies fine sand, silt, and clay that were deposited in an extensive proglacial lake. The depth, thickness, and character of deeper units are poorly known. Several domestic wells obtain water from gravel beneath the lacustrine unit at depths from 55 to 110 feet, but one test hole (29-42b, fig. 23) penetrated only silty clayey gravel beneath the lacustrine unit, and a few holes reportedly penetrated to depths of 175 feet or more without obtaining water. A few low-lying areas on the valley train contain surficial silt, which probably represents postglacial filling of depressions caused by compaction of sediment or late melting of ice. The low area northeast of Bridgewater, about 1,180 feet in altitude, contains organic silt atop gravel at Route 20 and may be of similar origin.

Ice-contact deposits mapped along the west side of the valley are thin and probably unsaturated in some areas. However, ice-contact gravels a half-

EXPLANATION

fp — FLOOD-PLAIN, SWAMP, BOG DEPOSITS--Layered clay, silt, fine sand, and organic muck overlying silty gravel

af — ALLUVIAL FAN--Silty sand and gravel deposits of tributary streams

o — OUTWASH--Layered sand and gravel

it — ICE-CONTACT DEPOSITS, KAME TERRACE--Layered gravel, sand, variably silty; along valley walls, some level surfaces.

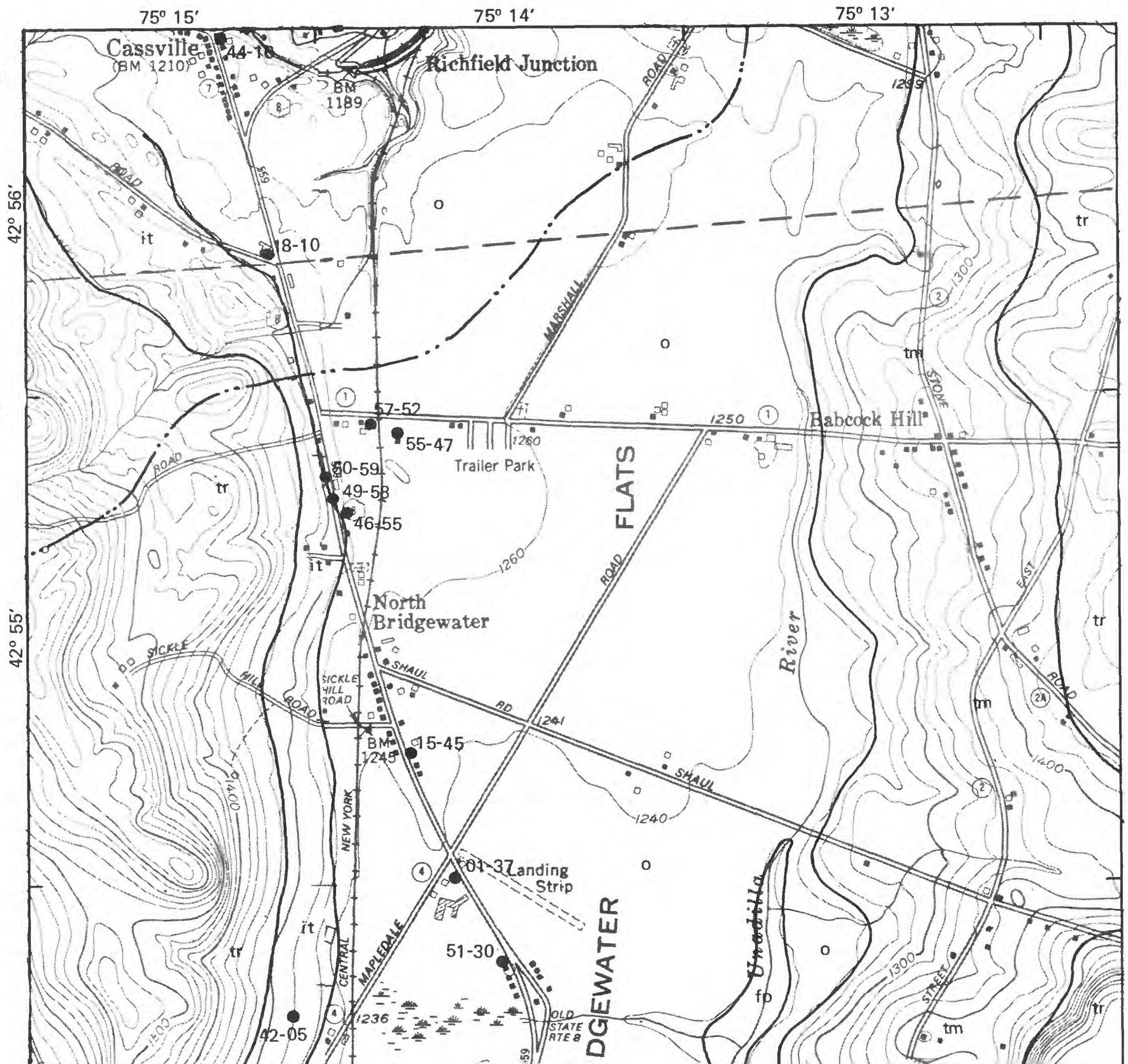
tm — TILL, MORAINAL--Mixed silt, clay, stones, and sand; may be underlain by ice-contact deposits or outwash, hummocky topography

tr — TILL--Mixed silt, clay, stones, and sand; underlain by bedrock, generally at shallow depth

CONTACT--Dashed where approximately located

44-38b — WELL--Number is seconds of latitude and longitude (degrees and minutes are shown in margins). b=test hole

DRAINAGE DIVIDE



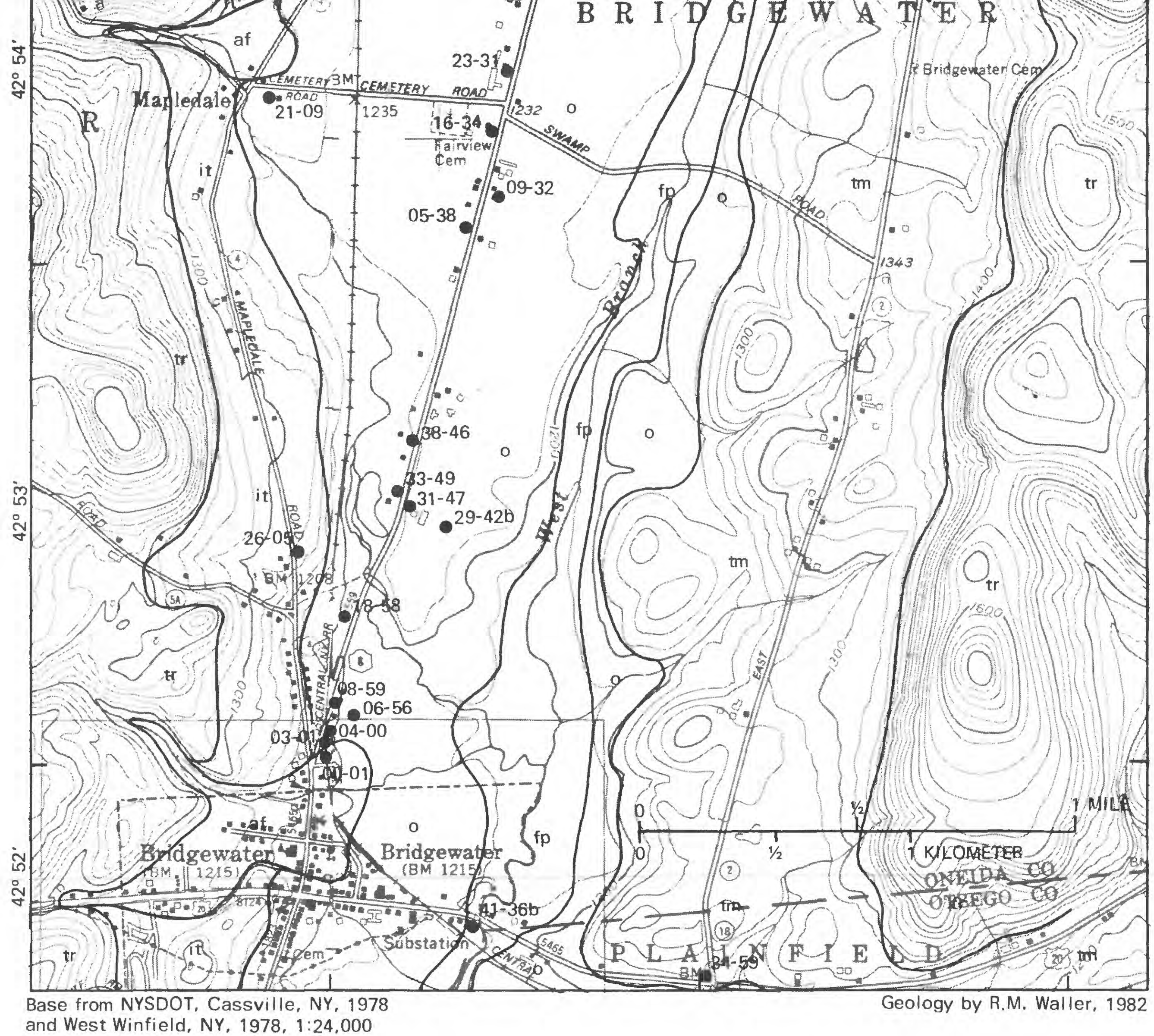


Figure 19.--Reconnaissance map of Bridgewater Flats valley showing surficial geology and well and test-hole locations.

mile north of Bridgewater supplies water to at least one well and may extend eastward beneath outwash just north of Bridgewater, as suggested by several wells near the railroad that penetrate 40 to 60 feet of sand and gravel.

The unconsolidated deposits along the east side of the valley are mapped as ablation moraine and consist mostly of till.

Hydrology.--The outwash that underlies the valley floor constitutes an extensive but probably rather thin surficial aquifer. The water table is within 20 feet of land surface nearly everywhere and is commonly within 5 feet of land surface near the west side of the valley train, especially during the spring, when abundant runoff from adjacent upland descends onto and infiltrates into the outwash. One well at Mapledale and another just north of Bridgewater overflow during the spring (table 7); both are on alluvial fans of tributary streams, and the water levels above land surface probably reflect abundant recharge near the heads of the fans during the spring freshet. Some recharge from these tributaries continues throughout the year, but at smaller rates during the summer. Saturated thickness of the surficial aquifer is probably 20 to 30 feet in the valley reach north of North Bridgewater but decreases to about 10 feet south of Mapledale except in a narrow zone along the railroad north of Bridgewater, where outwash may overlie ice-contact deposits and saturated thickness probably exceeds 40 feet. Perennial flow of West Branch Unadilla River is estimated to start east of North Bridgewater.

Evaluation.--The large size and lithologic character of Bridgewater Flats justify further investigation of the potential for seasonal withdrawal. The valley may be capable of sustaining substantial seasonal pumpage without serious decrease of streamflow.

Saturated thickness of the surficial aquifer seems less than ideal, but an array of large-diameter wells could be designed to tap a surficial aquifer 20 to 30 feet thick. However, the sparse records in table 7 do not rule out the possibility of greater saturated thicknesses. Hollyday (1969, table 1) estimated that efficient wells yielding an average of 1,000 gallons per minute could be constructed in such an aquifer, but this yield might not be sustainable after seasonal withdrawals reduce the saturated thickness. The reach from the divide to slightly south of North Bridgewater is the most promising for seasonal development of the surficial aquifer for two related reasons--saturated thickness and average grain size are greatest there, and the southward decrease in saturated thickness means that the cone of depression would not propagate effectively southward; thus only the uppermost reach of West Branch Unadilla River would be dried up.

The extent and permeablity of the aquifer(s) beneath the lacustrine deposits are unknown. Further investigation might document the presence of a major aquifer largely isolated from the West Branch Unadilla River.

Madison-Bouckville

Valley setting.--The Madison-Bouckville through valley is in the town of Madison in east-central Madison County (figs. 2, 20). The southwestern end joins the Pinewoods through valley. The Madison-Bouckville valley is about 1 mile in width throughout its length of more than 1.5 miles. The abandoned Chenango canal traverses the valley and now acts as a drain leading all runoff from this valley and the Pinewoods valley northeastward out of the Susquehanna basin into Oriskany Creek of the Mohawk basin. Several lakes lie near Madison and at the junction with the Pinewoods valley.

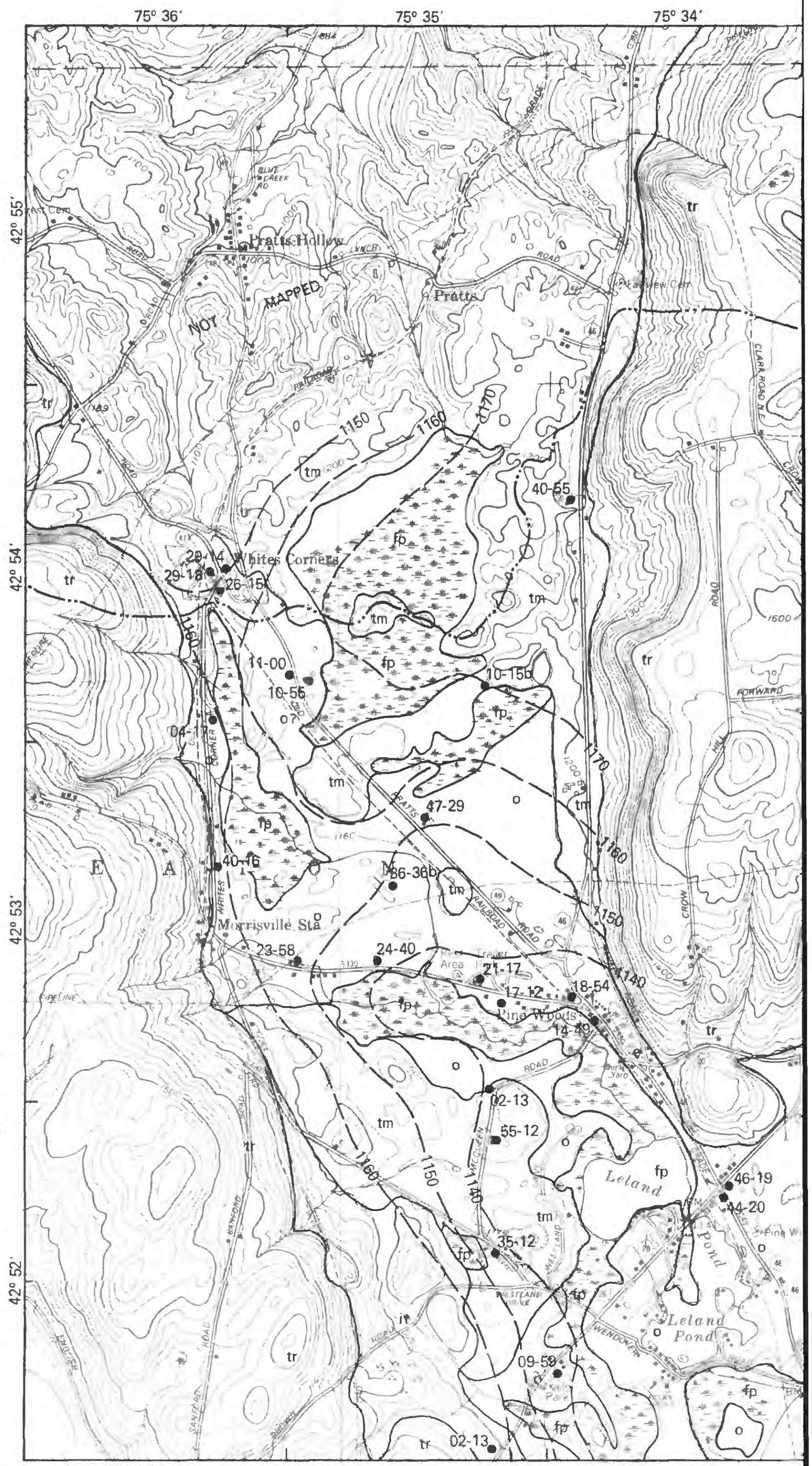
Surficial geology.--Outwash deposits dominate the valley floor (fig. 20). The outwash is pitted extensively in the Madison area, where some depressions intersect the water table and form lakes. Coarse gravel at land surface grades downward into finer gravel and fine to coarse sand of deltaic origin; grain size also decreases to the southwest, and a sandy outwash parallels the north side of the canal throughout the valley. The outwash is overlain by thin flood-plain deposits near the canal and by lacustrine silt south of Bouckville. Alluvial fans have been built out onto the valley floor in several places. The large fan at the extreme western end of the valley probably formed from meltwater flowing through the bedrock notch from ice in Pinewoods valley.

Well data (table 7 and fig. 20) indicate that the outwash ranges in thickness from less than 40 feet at the southwestern end of the valley to at least 60 feet near Madison Lake. No records of wells deep enough to reveal maximum outwash thickness near Madison Lake have been obtained. However, a well north of Solsville (Brigham, 1897) penetrated 75 feet of gravel over 38 feet of sand. A thick sequence of fine sand, silt, and clay (lake deposits) generally lies between the outwash and the bedrock. Several wells reached bedrock beneath the lake deposits at depths of 200 to more than 300 feet (table 7); only one of these wells (14-30) penetrated gravel beneath the lake deposits.

Hydrology.--The surficial outwash aquifer is coarse and highly permeable, hence throughout the valley the water table nearly coincides with the water surface in the Chenango Canal, which drains the aquifer. Even at very low water stage in September 1982, flow was evident in the canal from the west end (altitude about 1,130 feet) to the east end of the valley (altitude 1,120 feet at Solsville). Because the canal slopes gently northeastward, runoff from the Madison-Bouckville through valley is now part of the Mohawk River basin; the divide shown on figure 20 represents the former natural condition. The canal was cleaned and deepened about 4 feet about 1970, which probably lowered the adjacent water table somewhat.

Direct precipitation on the valley floor recharges the aquifer, as does runoff from the hillslopes and seepage from tributary streams. The combined lower reach of two tributaries from the north parallels the valley axis west of Solsville; this reach, like the canal, carried flow in September 1982 and may drain the aquifer.

Several wells at and north of Bouckville bottom at an altitude of about 1,125 feet, 5 to 10 feet below the water table and probably near the base of the outwash gravel. Thus, saturated thickness of highly permeable gravels may be as little as 10 feet in this area. However, a few records (table 7) suggest that coarse and fine sands of deltaic origin beneath the gravel may bring total saturated thickness of the surficial aquifer to 20 or 30 feet near Bouckville, and the entire outwash/deltaic sequence may thicken or coarsen eastward.



EXPLANATION

fp FLOOD-PLAIN, SWAMP, BOG DEPOSITS--Layered clay, silt, fine sand, and organic muck; underlain by outwash

la LACUSTRINE DEPOSITS--Clay, silt, very fine sand; thin, underlain by outwash

o OUTWASH--Layered sand and gravel

it ICE-CONTACT DEPOSITS, KAME TERRACE--Layered gravel, sand, variably silty; along valley walls, some level surfaces

tm TILL, MORAINAL--Mixed silt, clay, stones, and sand; underlain by ice-contact deposits or outwash; hummocky topography

tr TILL--Mixed silt, clay, stones, and sand; underlain by bedrock, generally at shallow depth

——— CONTACT

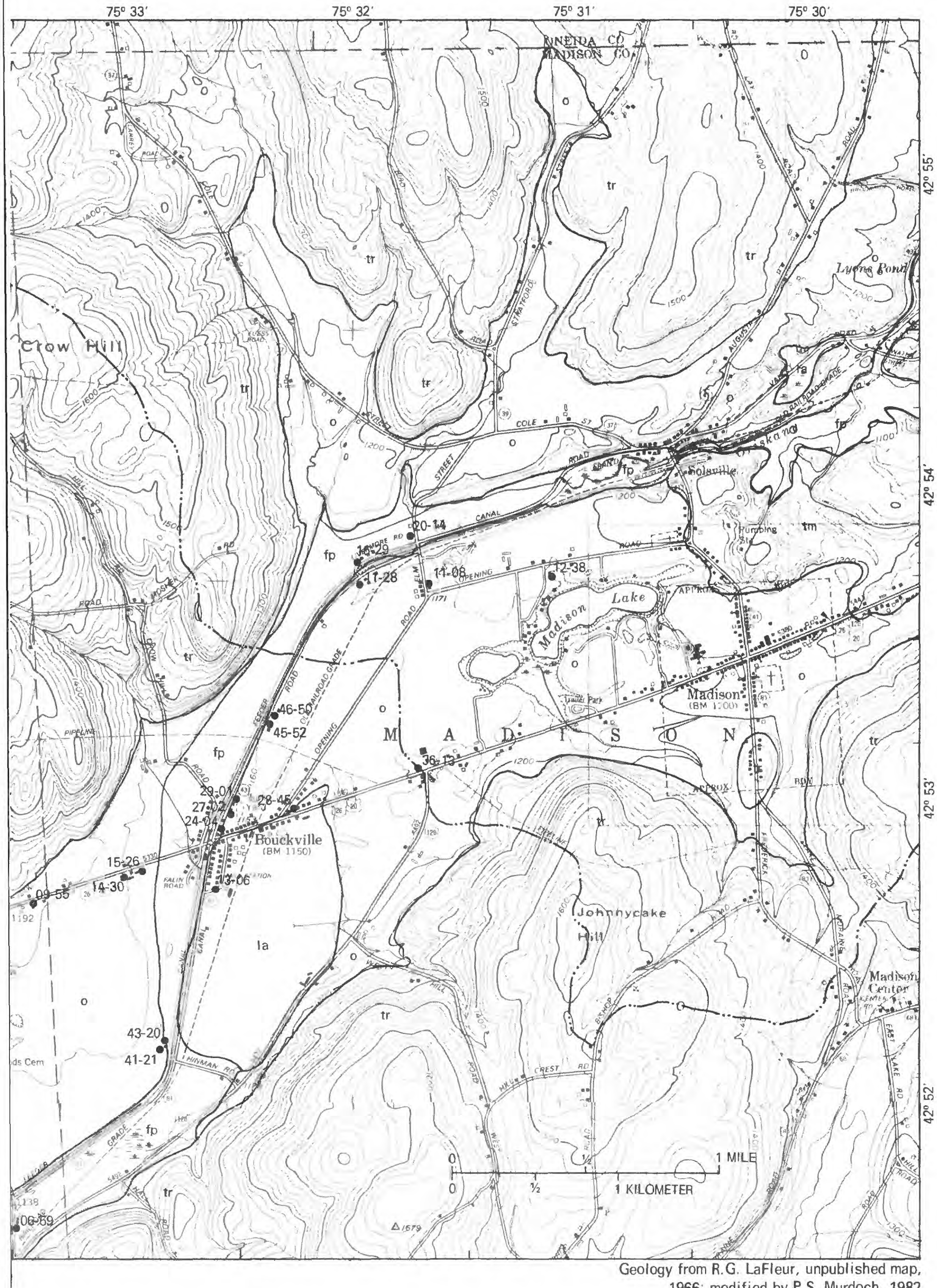
•44-36b WELL--Numbers are seconds of latitude and longitude (degrees and minutes are shown in margins). b=test hole

—··— DRAINAGE DIVIDE

— — — LINE OF EQUAL WATER-TABLE ALTITUDE--Contour interval 10 feet. Datum is sea level

Base from NYSDOT, Munnsville, NY, 1981 and Hamilton, NY, 1981, 1:24,000

Figure 20.--Reconnaissance map of Pinewoods valley and Madison-



Geology from R.G. LaFleur, unpublished map, 1966; modified by P.S. Murdoch, 1982

Bouckville valley showing surficial geology and well locations.

Evaluation.--Seasonal ground-water pumping from the thin but highly permeable surficial aquifer would be feasible almost anywhere on the valley floor. Likely effects include dewatering of nearby private wells, drying up of the canal (which currently functions as a diversion ditch to Oriskany Creek), and possibly lowering of lake levels. The apparent high conductivity of the aquifer might make a well-designed well-field system feasible, possibly in conjunction with seasonal regulation of canal stage. Saturated thickness is probably less than ideal for efficient development, however. Further exploration to define the maximum depth of permeable surficial sands, particularly at the east end of the aquifer, would be needed for a more complete evaluation.

Pinewoods

Valley setting.--The Pinewoods through valley lies in the town of Eaton in east-central Madison County; its south end joins the Madison-Bouckville valley (figs. 2, 20). The valley is about 2.6 miles long and 1 mile wide. The valley floor is hummocky, with swamps or lakes filling the shallow depressions. The northernmost swamp straddles the drainage divide. Drainage to the north enters Blue Creek, a tributary to the Oneida River. Three small tributaries enter the valley from the western side.

Surficial geology.--The valley floor is generally underlain by a near-surface layer of outwash sand and gravel 25 to 30 feet thick (fig. 20). Older ice-contact deposits line the sides of the valley. North of Morrisville Station, the valley floor is crossed by three hummocky ridges that may reflect terminal moraine positions or ice-crevasse fillings; a test hole (10-15b) near one of these ridges penetrated sand and gravel to a depth of 61 feet beneath till. In areas mapped as morainal till (fig. 20), a surficial till layer caps outwash or ice-contact deposits. The late ice readvance that deposited the till must also have crossed areas mapped as outwash or flood plain north of Leland Pond. The till in these areas may be covered by younger outwash and (or) alluvial swamp or muck deposits, or it may be thin and poorly exposed.

Beneath the outwash are clays and silts up to 250 feet thick. Sand and gravel units are present within or beneath these lake deposits in several places, particularly near and west of Pinewoods. No well data were available to indicate the depth to bedrock, but by analogy with the Madison-Bouckville valley, as much as 300 feet of sediments may be present in the Pinewoods valley. In summary, topography and records of boreholes in Pinewoods valley suggest that the stratified drift was deposited on down-wasting ice without the large volumes of meltwater that would have formed more extensive outwash or kame terraces.

Hydrology.--The stratified deposits receive recharge from precipitation and runoff. They are saturated nearly to land surface north of Route 20, except for hummocky terraces near the valley side. Consequently, the master stream and wetlands on the valley floor are perennial. West of Leland Pond, the stratified drift is hummocky and contains kettles. The one stream in this area terminates in a kettle, indicating that the deposits here are very permeable and well drained.

Water-table contours (fig. 20) show that the ground-water divide coincides closely with the surface-water divide, and ground water moves toward the streams and lakes. The contours are based on water-level measurements in nearly half the wells visited (see table 7) and altitudes of wetlands and lakes. Near Route 20, two wells more than 100 feet deep had water levels about 10 feet below the water levels in nearby shallow wells. Another well, 320 feet deep, had a water level 17 feet below that of shallow wells. This contrast in head suggests that the lake deposits overlying the deeper aquifer are continuous over much of the valley near Route 20. The deeper aquifer either drains north (beneath the divide) to points of outcrop near Pratts Hollow or drains south to some area of lower head. The lacustrine unit may pinch out to the south, perhaps southwest of Leland Pond, permitting unobstructed upward flow.

Evaluation.--The saturated thickness of the surficial aquifer is probably greatest northeast of the railroad, and seasonal withdrawals in this area would have the least effect on streamflow. Near the east valley wall, saturated thickness may exceed the 10 to 25 feet reported near the railroad, but further exploration would be needed to verify aquifer thickness.

Several well records demonstrate the presence of a buried aquifer in an area extending at least a mile west and northwest from the hamlet of Pinewoods. The thickness and water-yielding capacity of this aquifer are unknown, but it may consist of stratified-drift deposits continuous with those west of Leland Pond, which seem permeable. If large-scale seasonal pumping from this aquifer were possible, it would probably have little short-term effect on streamflow.

The presence of two aquifers over large areas in the Pinewoods through valley would permit a management strategy in which one aquifer is used for large seasonal withdrawals and the other reserved for domestic and other scattered small local needs.

Lowered water levels due to seasonal ground-water withdrawal in Pinewoods valley might reduce the flow of springs tributary to Blue Creek and flow in the Chenango Canal diversion to Oriskany Creek (see section on Madison-Bouckville aquifer) but would not affect the Chenango River basin.

Sheds

Valley setting.--This narrow through valley lies north of the hamlets of Sheds and Sheds Corners in southwestern Madison County (figs. 2, 21). It is about 0.5 mile wide and 1.5 miles long. Southward drainage enters Middle Branch Tioughnioga Creek, whereas northward drainage is to East Branch Limestone Creek of the Oneida River system. The relatively small valley floor is dominated by a large wetland. The western side of the valley is bordered by a nearly straight, steep-sided hill (Kinney Hill). The east side is more open, with an irregular hill forming the divide.

Surficial geology.--The through valley is dominated by stratified drift (ice-contact and lacustrine deposits) on most of the valley floor. The large mass of drift that forms the divide on the east side of the valley is chiefly

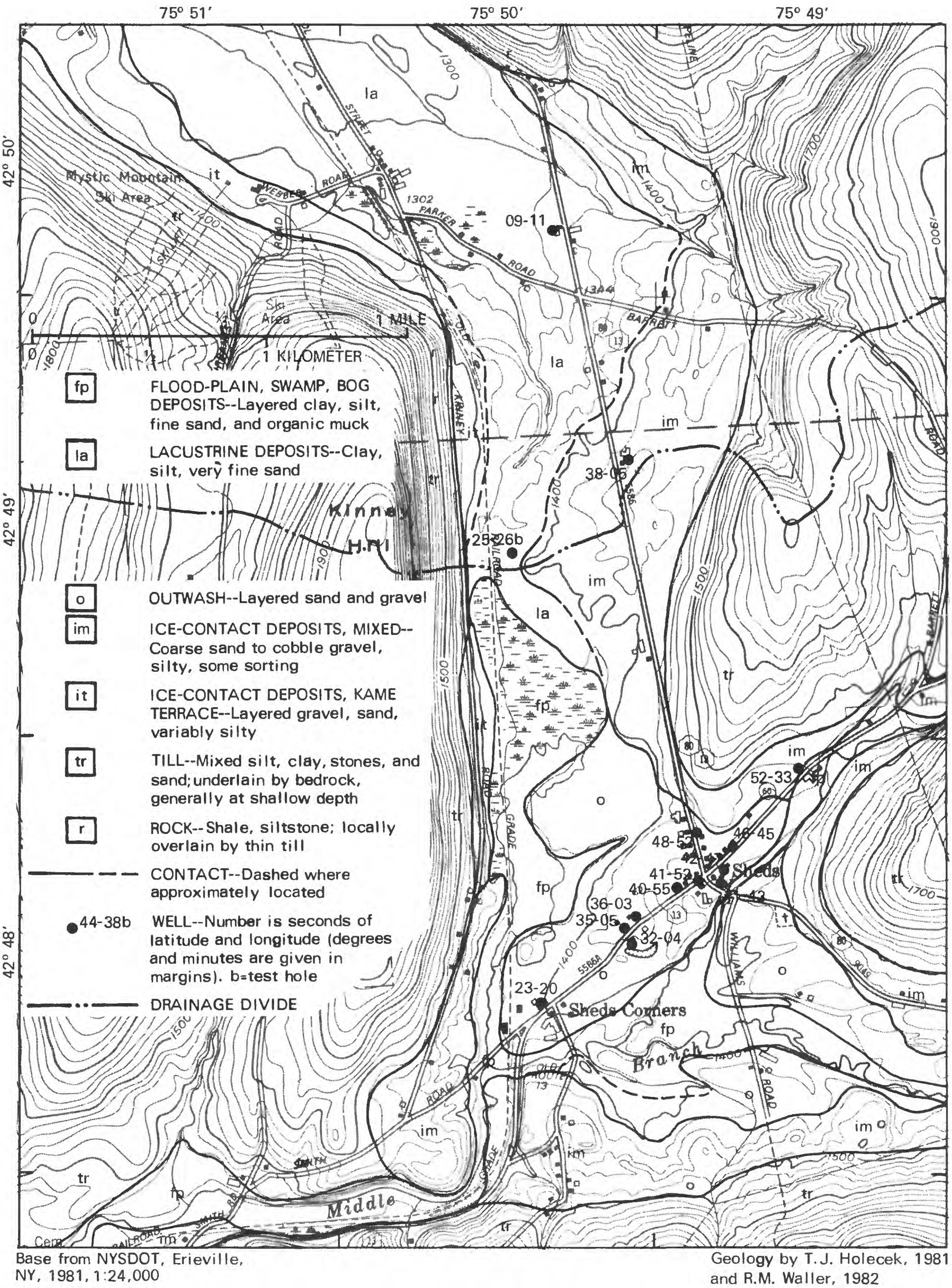


Figure 21.--Reconnaissance map of Sheds valley showing surficial geology and well and test-hole locations.

composed of or capped by poorly sorted silt, sand, and gravel (fig. 21). Proglacial lake deposits of clay and silt are found at lower altitudes near the divide and continue north beyond New Woodstock. The swampy area south of the divide, mapped as flood plain, is underlain by gravel on top of clay and silt. The low ridge extending from Sheds to Sheds Corners, which nearly blocks the south end of the valley, may represent a brief episode of meltwater deposition. At the surface is sand and gravel 20 feet thick, which overlies more than 100 feet of silty clayey sediment containing thin, fine sandy layers, as inferred from well records (fig. 21, table 7). Modern streams have extensively meandered over the Middle Branch valley floor and deposited a foot or more of silt.

Hydrology.--The only stream system in the Sheds through valley is the extensive wetland, which drains to the south. Tributaries from the east enter north of the divide or south of the outwash terrace at Sheds. Hence, recharge to an aquifer in the through valley would come only from overland runoff and direct precipitation.

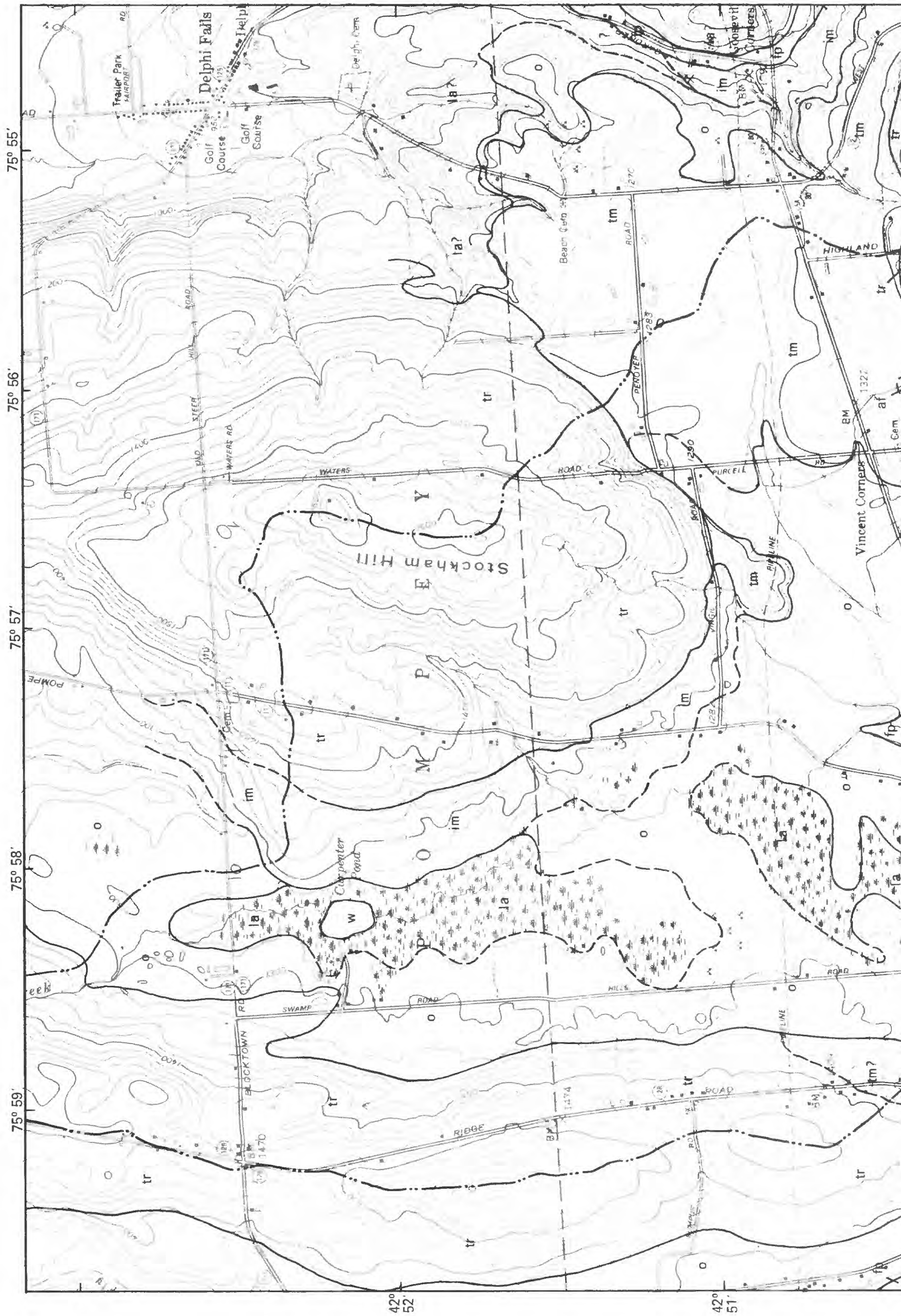
Subsurface data are sparse, but minor aquifers seem to be present beneath the outwash terrace from Sheds to Sheds Corners, and near land surface on the irregular hill that forms the divide on the east side of the valley. No major aquifer is indicated, however. Ground-water movement is considered to generally follow the land-surface gradient, and the ground-water divide is approximately at the surface-water divide.

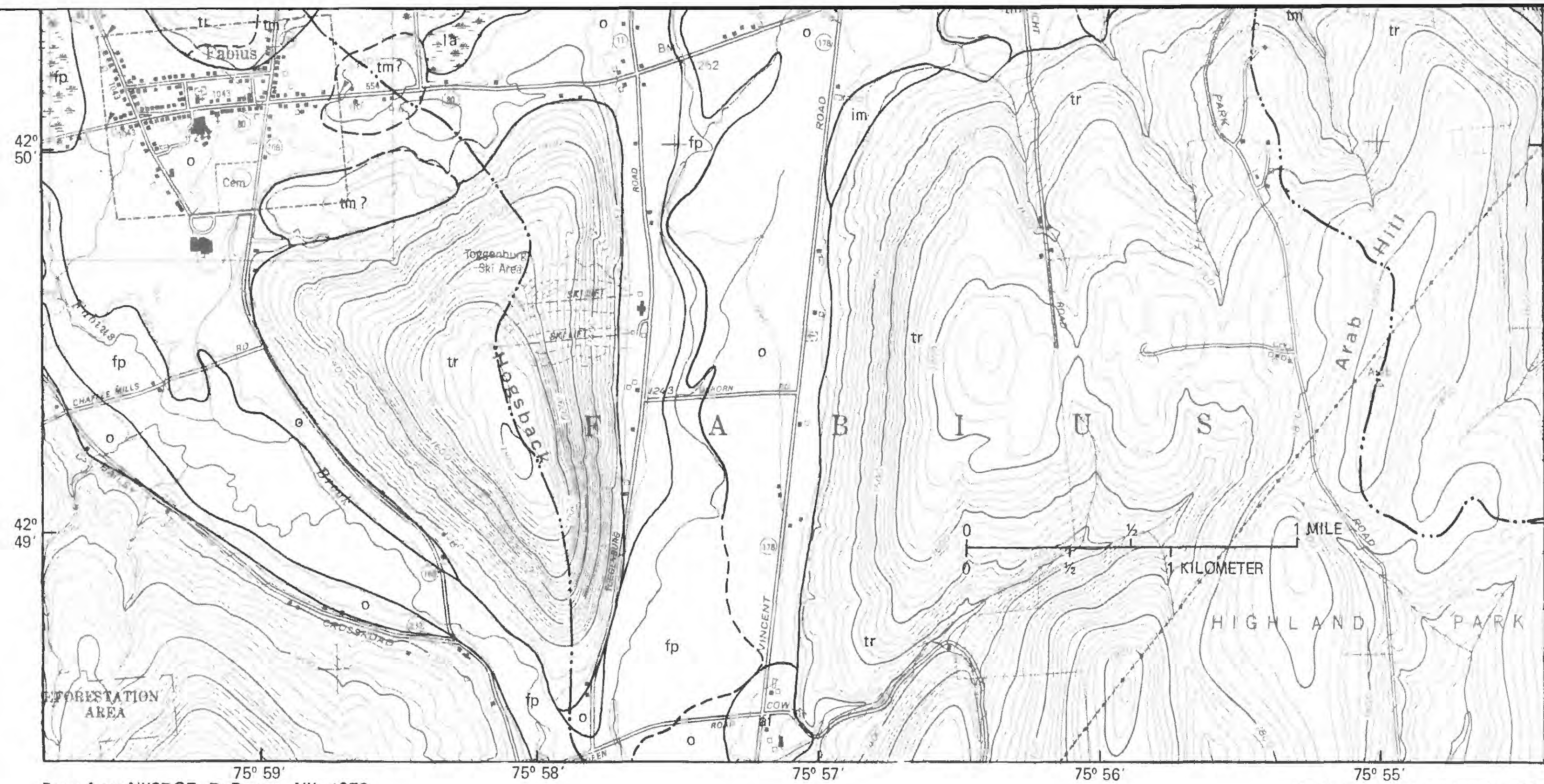
Evaluation.--The Sheds through valley shows no evidence of a significant aquifer. If a buried aquifer were present near the divide, pumping from that aquifer would have little effect on streamflow because fine-grained deposits probably are extensive at shallow depth near Middle Branch Tioughnioga Creek and beneath the large wetland area.

Fabius

Valley setting.--This through valley is in southeastern Onondaga County (fig. 2) near the Village of Fabius. It consists of intersecting through valleys that trend north-south and nearly east-west; the former are slightly offset at the intersection (fig. 22). All are drained by West Branch Tioughnioga Creek. The north-south limbs have a combined length of about 5 miles and are 0.5 to 1 mile wide. Drainage beyond the divide on the east limb descends steeply to Limestone Creek of the Oswego River system. The west limb connects to the broad valley of Fabius Brook, which joins West Branch Tioughnioga Creek south of the reach considered here.

Surficial geology.--Three types of glacial deposits are dominant on the valley floor--outwash, morainal till, and lacustrine deposits (fig. 22). Outwash gravels underlie a slightly hummocky valley floor in the central part of Fabius valley and also underlie gently sloping terraces near Carpenter Pond in the north limb. The gravels may be continuous beneath swamp deposits (mapped as lacustrine) in the north limb and are probably continuous beneath thin till near the divide in the east limb; they are overlain by silty alluvium along the axis of the south limb. The outwash was deposited by meltwater from separate ice lobes at the heads of the east, north, and west limbs, which deposited three valley trains that merge and extend down the south limb. Some of the outwash, especially in the north limb, was deposited in contact with ice.


Delphi Falls
Golf Course
Trailer Park
Stockham Hill
Vincent Corners
Carpenter Pond
75° 55′
75° 56′
75° 57′
75° 58′
75° 59′
42° 52′
42° 51′



Base from NYSDOT, DeRuyter, NY, 1978 and Oran, NY, 1978, 1:24,000

Geology by T.J. Holecek, 1981

EXPLANATION

fp — FLOOD-PLAIN, SWAMP, BOG DEPOSITS--Layered clay, silt, fine sand, and organic muck, overlying silty gravel

af — ALLUVIAL FAN--Silty sand and gravel deposits of tributary streams

la — LACUSTRINE DEPOSITS--Clay, silt, very fine sand

o — OUTWASH--Layered sand and gravel

im — ICE-CONTACT DEPOSITS, MIXED--Coarse sand to cobble gravel, silty, some sorting

tm — TILL, MORAINAL--Mixed silt, clay, stones, and sand; underlain by ice-contact deposits or outwash, hummocky topography

tr — TILL--Mixed silt, clay, stones, and sand, underlain by bedrock, generally at shallow depth

w — OPEN WATER

— — —— CONTACT--Dashed where approximately located

——··—— DRAINAGE DIVIDE

Figure 22.--Reconnaissance map of Fabius valley showing surficial geology.

A sheet of till (tm in fig. 22) covers the valley floor in much of the east limb and overlies the outwash gravel, as seen in boreholes and in pits along the bluff above Limestone Creek. It is a thin layer deposited from a final readvance of the glacier. Immediately to the west, near Vincent Corners, three till-covered hills rise to altitudes above 1,320 feet near the base of the valley wall. Their location at the outer edge of the till sheet suggests that they represent morainal deposits of the final ice readvance and overlie the outwash gravel or possibly interfinger with it. This interpretation is shown in section A-A' (fig. 23). Two similar features occur near Fabius (fig. 22 and section B-B' in fig. 23). An alternative interpretation is that these low knobs near Vincent Corners and Fabius originated much earlier, perhaps as morainal or ice-contact features related to an ice tongue in advance of the continental ice sheet. This intepretation is supported by the presence of low eskerlike ridges on Stockman Hill and on the nearest till knob, and by a contrast in pebble lithology between surficial till on two of these knobs and the till sheet on the valley floor; the former is rich in local bedrock fragments while the latter contains abundant fragments of exotic pebbles from regions to the north (Hutton and Rice, 1977). If this alternative interpretation is correct, the outwash merely laps against these hills but is not continuous beneath them.

Till was penetrated at a depth of 74 feet in a borehole (39-56b in fig. 24; section C-C' in fig. 23) at the south end of the northern limb of the valley system. Its relationship to the till on the valley wall is uncertain, but its characteristics are similar to soil descriptions of till on the valley walls, which suggests that they may be a single unit.

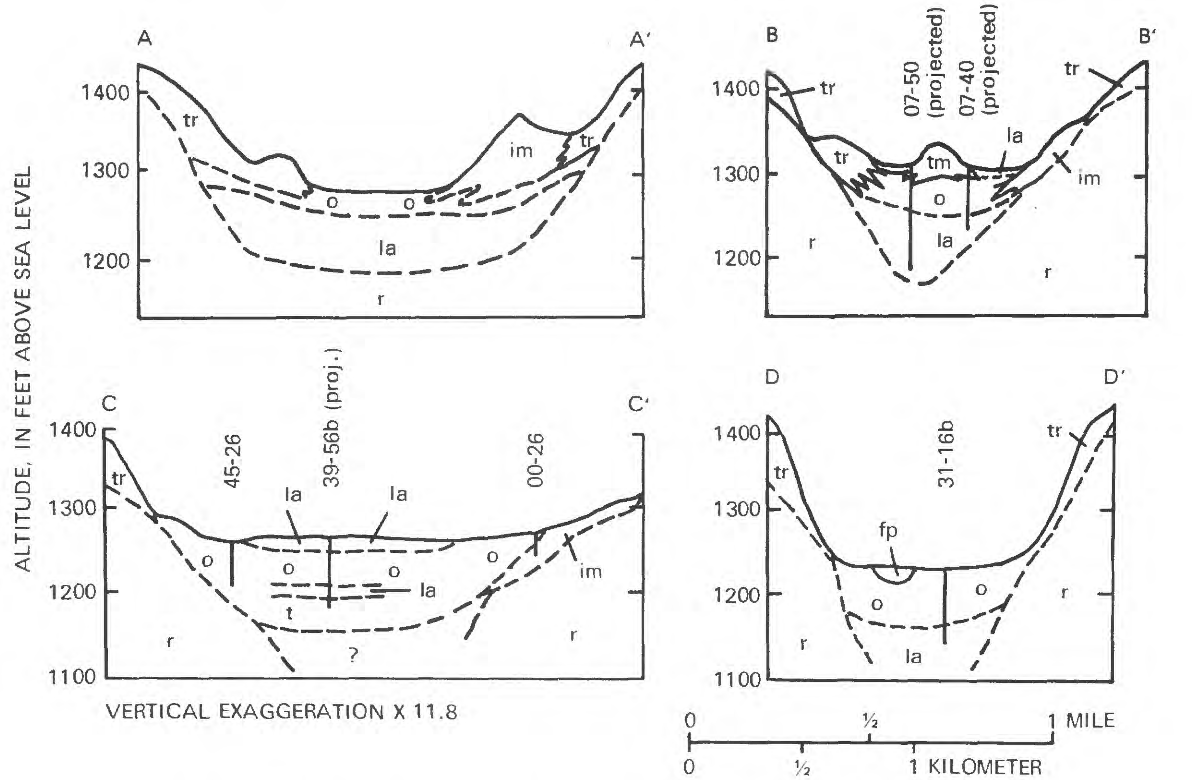


Figure 23.--Generalized geologic sections in Fabius valley. (Explanation given in fig. 22; location of sections in fig. 26.)

Lacustrine clay and silt are widespread beneath the outwash throughout the Fabius through-valley system. Soils maps and a few exposures suggest that a thick section of lacustrine clay and silt interbedded with gravel layers underlies the surficial till and outwash in the bluff along Limestone Creek. Borehole logs and well records reveal lacustrine deposits beneath the outwash in the west and south limbs of the valley. Only a thin layer of clay, then till, was penetrated beneath outwash in the borehole at the south end of the north limb.

Hydrology.--The floor of Fabius valley is characterized by low relief and a water table at or close to land surface over large areas of stratified drift. Extensive marshes dominate the north limb, and several beaver dams raise water levels along West Branch Tioughnioga Creek. Drainage tiles have been installed in at least one field west of Vincent Road to lower the water table.

Streamflow measurements, listed below, were made at several sites on two dates to estimate ground-water discharge as underflow from Fabius valley. Both dates followed at least 5 days of dry weather and a substantial period of subnormal precipitation. Although ground-water discharge as streamflow differed widely on the two dates, ground-water discharge as underflow should have been the same because West Branch Tioughnioga Creek flowed continuously, which means the downvalley component of the water-table gradient and saturated thickness of the aquifer must have remained essentially constant. The measurements were made early and late in the growing season, when temperatures dropped below freezing most nights and ground-water discharge by evapotranspiration was presumably small, especially in October, when swamps contained less standing water than in April.

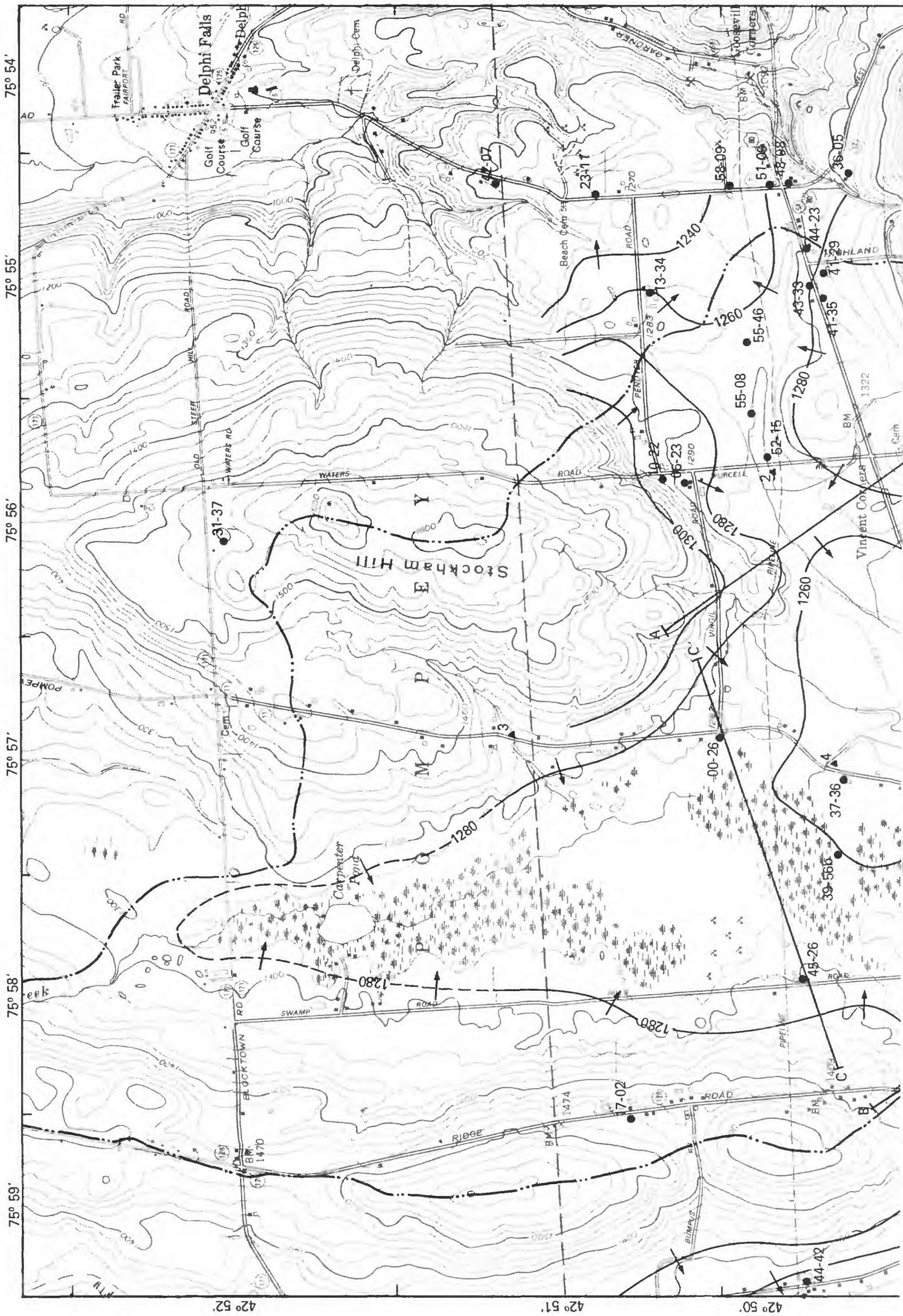
Date	Streamflow, in cubic feet per second (Site locations shown in fig. 24.)					
	Site 1	Site 2[a]	Site 3	Site 4	Site 5	Site 6
April 23, 1981	0.21	0.41	0.65	4.41	7.70	11.20
October 8, 1982	-- [b]	0 [c]	-- [b]	.20	.13	1.04

a Stream relocated in artificial channel near this site.
b Site not visited on this date.
c Very small flow, estimated 0.02 ft^3/s, 500 feet upstream.

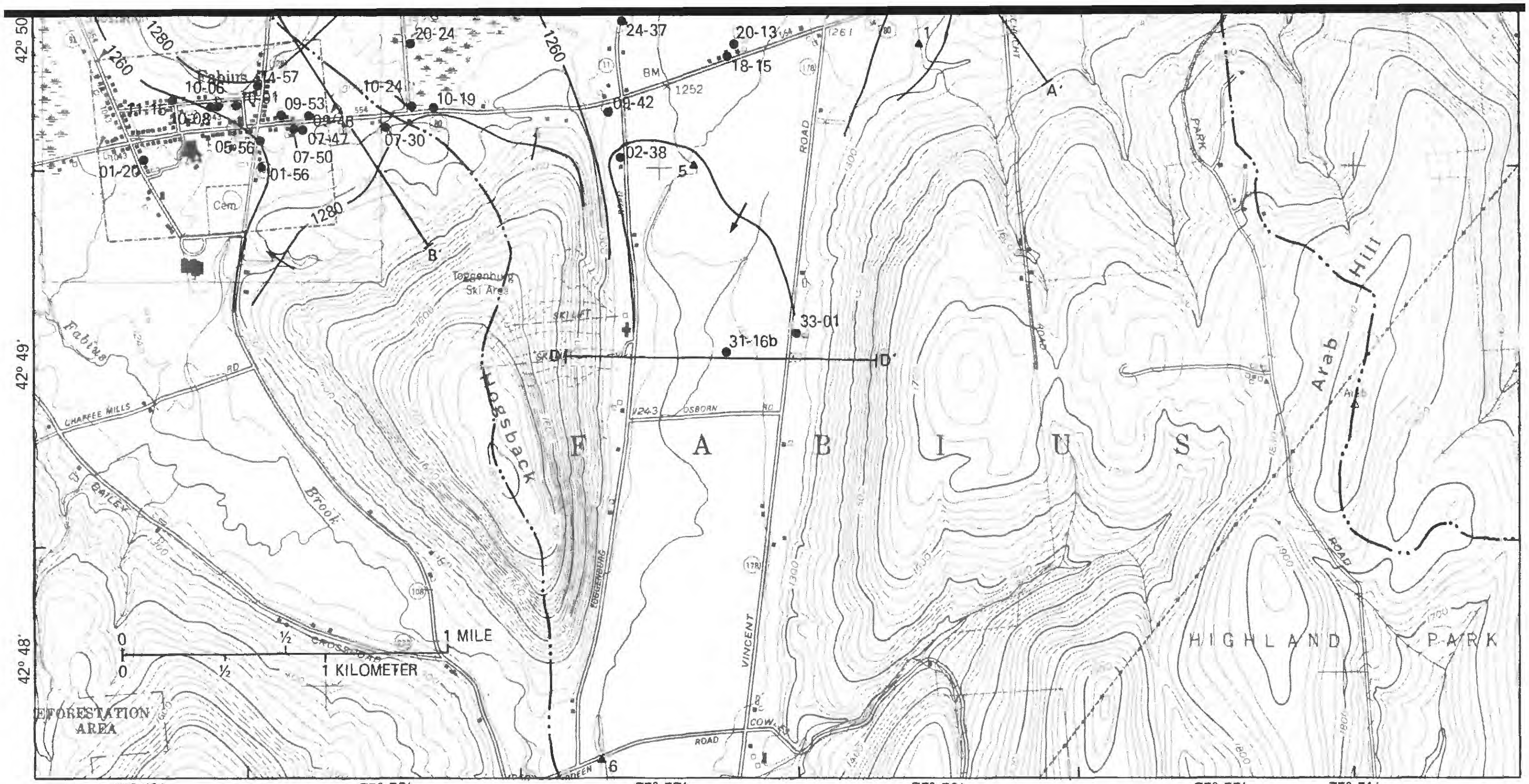
Underflow in the south limb of Fabius valley may be estimated from these measurements under the following assumptions:

1. Underflow beneath site 5 is the same as that beneath site 6--a plausible assumption because valley width is the same, and the uniform topography offers no suggestion of change in lithology or thickness.

2. Ground-water runoff is proportional to area of stratified drift (Ku and others, 1975) except for areas on the valley side above 1,310 feet altitude, where ice-contact deposits may be unsaturated and(or) interlayered with till, and areas underlying swamps and ponds, which would not contain drainable ground water above stream grade.



75° 54'
75° 55'
75° 56'
75° 57'
75° 58'
75° 59'
42° 52'
42° 51'
42° 50'
Delphi Falls
Trailer Park
Golf Course
Stockham Hill
Carpenter Pond
Vincent Corners
1240
1260
1280
1300



Base from NYSDOT, DeRuyter, NY, 1978 and Oran, NY, 1978, 1:24,000

Hydrology by T.J. Holecek, 1981

EXPLANATION

▲ 5 STREAMFLOW-MEASUREMENT SITE

● 44-38b WELL--Number is seconds of latitude and longitude (degrees and minutes of latitude and longitude are shown in margins) b=test hole.

1200 — — LINE OF EQUAL POTENTIOMETRIC-SURFACE ALTITUDE--Contour interval 20 feet. Datum is sea level. Arrow indicates direction of flow.

A—A' LINE OF SECTION--Shown on figure 23

—··— DRAINAGE DIVIDE

Figure 24.--Potentiometric-surface altitude and locations of wells, test-holes, and stream-measurement sites in Fabius valley.

Ground-water discharge by underflow may be estimated by computing the gain in streamflow per square mile of stratified drift between site 5 and 6, applying the same rate to the corresponding area upstream from site 5, and subtracting the measured gain in streamflow between the edge of the stratified drift and site 5. Results suggest that underflow in the south limb of Fabius valley is a little less than 3 ft^3/s, but any such calculation for Fabius valley is made tenuous by the unproven assumptions, imprecise maps, and uncertainties as to evapotranspiration and surface storage in beaver ponds.

The surficial outwash gravels constitute the main aquifer in Fabius valley. Two widely separated boreholes (31-16b and 39-56b in fig. 24) penetrated 60 to 70 feet of outwash overlying lacustrine deposits, of which 40 to 60 feet were saturated. In the bluff along Limestone Creek, east of the divide, the outwash is also close to 50 feet thick, although largely unsaturated. The outwash may be thinner in the west limb at Fabius; well records suggest till near land surface locally and lacustrine deposits or till interbedded with gravel at greater depth.

The approximate configuration of the water table (fig. 24) was inferred from measured or reported depth to water in 24 wells, most of which tap the surficial outwash aquifer; some in the east and west limbs tap gravel interbedded with lacustrine deposits.

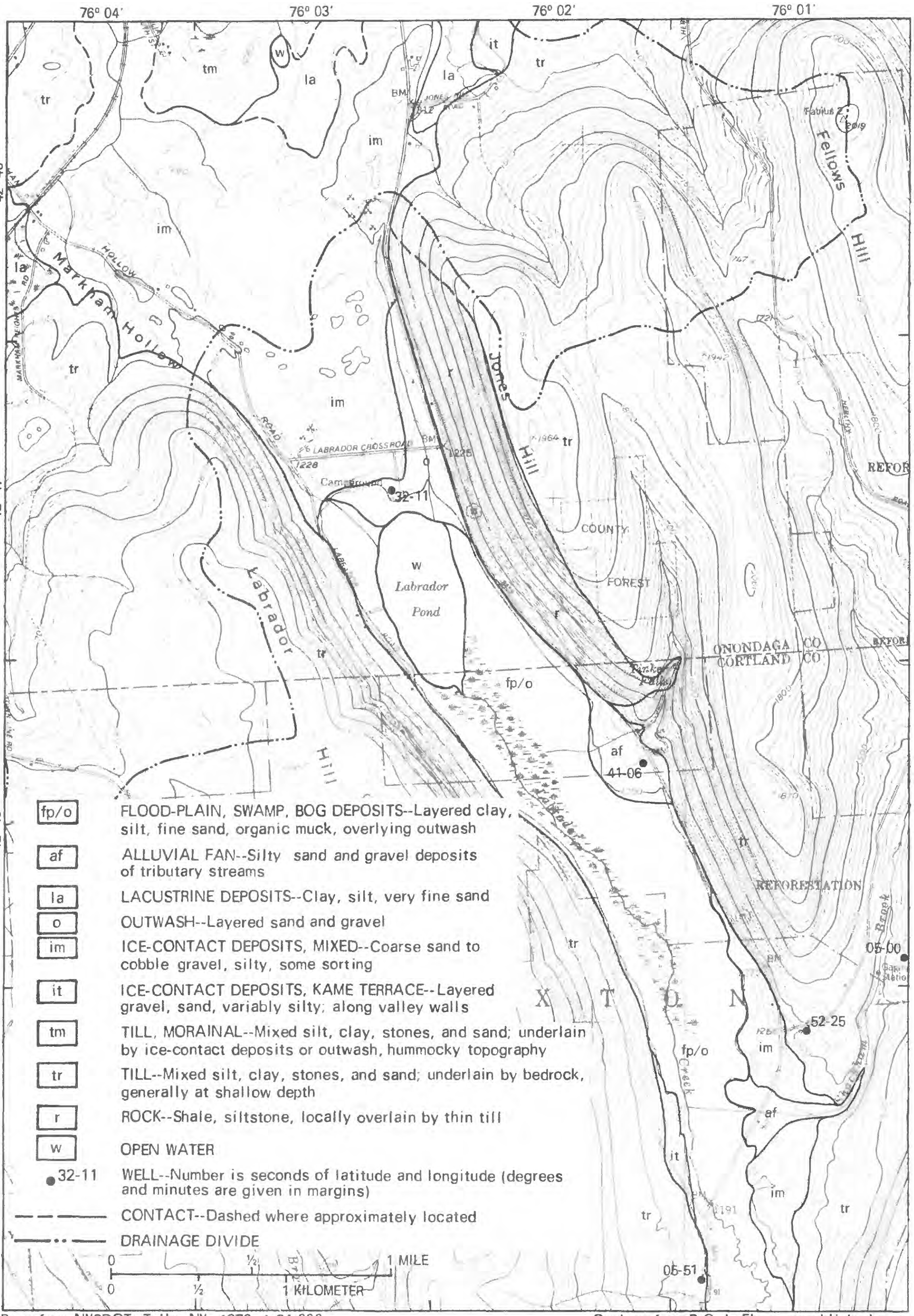
Evaluation.--The north, east, and south limbs of the Fabius through valley have aquifers capable of supplying large seasonal pumpage. The north limb is not well known and may have the least saturated thickness; extensive wetlands could potentially be drained by large seasonal ground-water pumping. The east limb lacks surface runoff in dry seasons, so pumping there would probably have little immediate effect on streamflow downvalley.

The west limb at Fabius does not appear highly permeable, and probably little ground water discharges westward beneath the ground-water divide. Most domestic wells at Fabius village are 50 feet or more in depth and would probably not be greatly affected by a lowered water table elsewhere in Fabius valley.

Labrador Pond

Valley setting.--The Labrador Pond through valley lies in southern Onondaga and northern Cortland Counties (figs. 2, 25). The headwater reach of the valley is about 3.5 miles long from the divide to the first sizeable tributary, Shackham Brook, and averages 0.5 mile in width. A 100-foot-high hummocky, sloping ridge plugs the north end of the through valley and forms the divide; the valley floor to the south is flat and waterlogged. Labrador Pond lies at the base of the ridge and drains south into Labrador Creek. Bedrock hills rise steeply more than 700 feet above the valley floor on both sides of the valley and form parallel boundaries as far south as Shackham Brook. Drainage north of the divide is to Butternut Creek of the Oneida River system.

Surficial geology.--The ridge that plugs the north end of the through valley is a poorly sorted to well-sorted ice-contact deposit that constitutes the terminal moraine of the last ice front (fig. 25). It is at least 150 feet thick. Shallow boreholes and gravel pits revealed at least 40 feet of poorly



Base from NYSDOT, Tully, NY, 1978, 1:24,000

Geology from R.G. LaFleur, unpublished map, 1966; modified by R.M. Waller, 1982

Figure 25.--Reconnaissance map of Labrador Pond valley showing surficial geology and well and test-hole locations.

sorted sand and gravel mantling the south slope of the moraine (D. Files, New York State Department of Environmental Conservation, oral commun., 1982), and much of the drift at greater depth is probably stratified. A well-defined meltwater channel lies along the east side of the moraine.

The level valley floor south of the moraine is presumably underlain by outwash. An appreciable thickness of sand and gravel at shallow depth beneath the valley floor is suggested by records of wells 1.5 miles south of Shackham Brook, but little subsurface information is available for the headwater reach. Extensive wetlands, Labrador Pond, and silty sediment deposited by postglacial runoff mantle the land surface on the valley floor. The pond averages 2.5 feet deep (maximum 5 feet) and has as much as 33 feet of muck in its bottom (D. Files, New York State Department of Environmental Conservation, oral commun., 1982). Clay crops out northwest of Labrador Pond. A well 400 feet north of the pond (fig. 25) penetrated water-yielding materials at a depth of 154 feet and overflows 3 feet above grade (table 7). These observations suggest that after outwash deposition ceased, the melting of buried ice lowered land surface enough to create a lake in which silt and clay and eventually organic muck accumulated to form a shallow confining layer beneath the northern part of the valley floor.

Two alluvial fans have been built out onto the valley floor by streams entering from the east side. A small kame complex is present near Shackham Brook. Thin till covers the steep bedrock hills.

Hydrology.--Subsurface data are insufficient to determine whether the moraine contains a significant aquifer. Hollyday (1969, table 1) estimated that well yields could range from 84 to 840 gal/min with 260 gal/min as a median. The two streams draining the moraine are seasonally dry (observed September 23, 1982). The shallow borehole data reported by D. Files (cited above) and the dry streams indicate a permeable surficial aquifer with a deep water table.

Labrador Pond and Creek are perennial and represent the water table south of the moraine. Outwash, in part confined beneath silt and clay, probably constitutes a significant aquifer downvalley from Labrador Pond.

Discharge of Shackham Brook was measured by the U.S. Geological Survey from 1932 through 1968 at the gaging station shown on figure 25; results were analyzed by Schneider and Ayer (1961) and Ku and others (1975). Infiltration from Shackham Brook to the alluvial fan and to ice-contact deposits within Labrador Pond valley is estimated to be about 1.5 ft^3/s (MacNish and Randall, 1982) as long as that much streamflow is available, which should be about 60 percent of the time (Ku and others, 1975, p. 96). These numbers are cited as an indication of potential recharge from tributary seepage to aquifers in this valley.

Evaluation.--Labrador Pond valley is considered to have a good potential for seasonal pumping, but subsurface information is meager, and test drilling would be required to define aquifer thickness and permeability. Seasonal pumping from an aquifer in the moraine area would probably have little effect on streamflow draining south. Large-scale pumping of ground water from the outwash south of Labrador Pond would dewater some of the wetlands, Labrador Creek, and perhaps Labrador Pond.

Preble Dry Valley

Valley setting.--Preble dry valley is the name commonly used for a through valley northwest of the hamlet of Preble in northern Cortland County (figs. 2, 26). South of the divide, the valley contains no perennial stream but is tributary to West Branch Tioughnioga River. The valley floor is 0.5 mile wide and 2.7 miles long from the divide to the mouth. Drainage north of the divide is deeply incised and flows to Otisco Lake. The valley walls are steep, forest covered, and rise about 600 feet above the valley floor. The southern part of the valley was included in ground-water appraisals of an adjacent valley by Buller (1978) and Miller and others (1981).

Surficial geology.--Three types of glacial deposits were identified in Preble dry valley (fig. 26A). Ice-contact deposits, principally gravel, underlie a broad hummocky terrace that slopes irregularly southward from a crest north of Williams Road and encompasses most of the valley as far south as Masters Road. Till immediately underlies land surface across much of the valley north of the divide and may interfinger southward into the ice-contact deposits. Outwash, principally gravel but slightly younger than the ice-contact gravel, was deposited downvalley by meltwater that cut a channel through the ice-contact gravel. The outwash forms a fairly level valley train that graded to a similar deposit in the Homer-Tully valley to the south and may be underlain by parts of the ice-contact deposits that slumped when buried ice melted.

Only one well (06-49, fig. 26B) near the valley axis is reported to reach bedrock; the reported casing length of 220 feet could not be verified but seems reasonable in that it is somewhat greater than that reported for wells near the valley wall. This information and records (Randall, 1972; Buller, 1978) in the adjacent Homer-Tully valley suggests a thickness of over 200 feet of saturated unconsolidated material all along the valley axis. Near the mouth of the valley, saturated permeable gravel is at least 70 feet thick and may be much thicker; near the divide the unconsolidated deposits may be predominantly till and silty gravel.

Hydrology.--Preble dry valley is unusual among the through valleys in that it totally lacks a perennial stream. All recharge to the gravel aquifers is derived from precipitation on the valley floor and from storm runoff that flows in wet-weather channels down the steep till-covered sides of the valley and infiltrates into the gravel on the valley floor. Local residents report that surface runoff during periods of rapid snowmelt in early spring briefly follows the former meltwater channel incised into the ice-contact deposits (fig. 26A). At such times, water levels rise in wells finished in gravel near the channel.

The ice-contact deposits and outwash constitute a single continuous aquifer, as suggested by water-table contours in figure 26B. The contours on this map are estimated from water levels measured or reported in only eight wells on different dates. South of the divide, the ice-contact deposits form permeable soils and are not unusually silty where exposed in a few pits to depths as great as 40 feet. Nevertheless, the following evidence suggests that the ice-contact deposits must be less permeable than the outwash, perhaps because of poor sorting and(or) interbedded till:

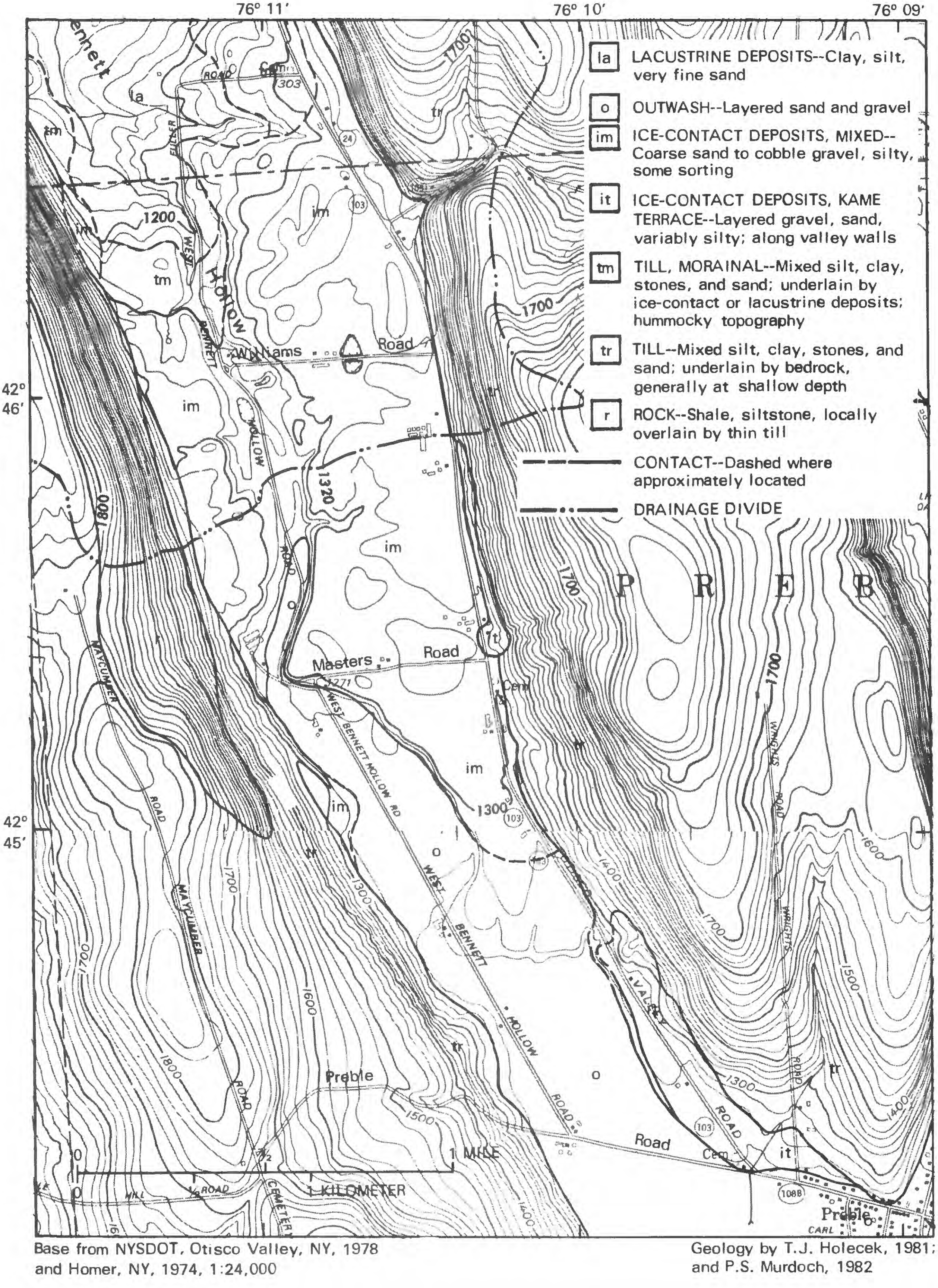
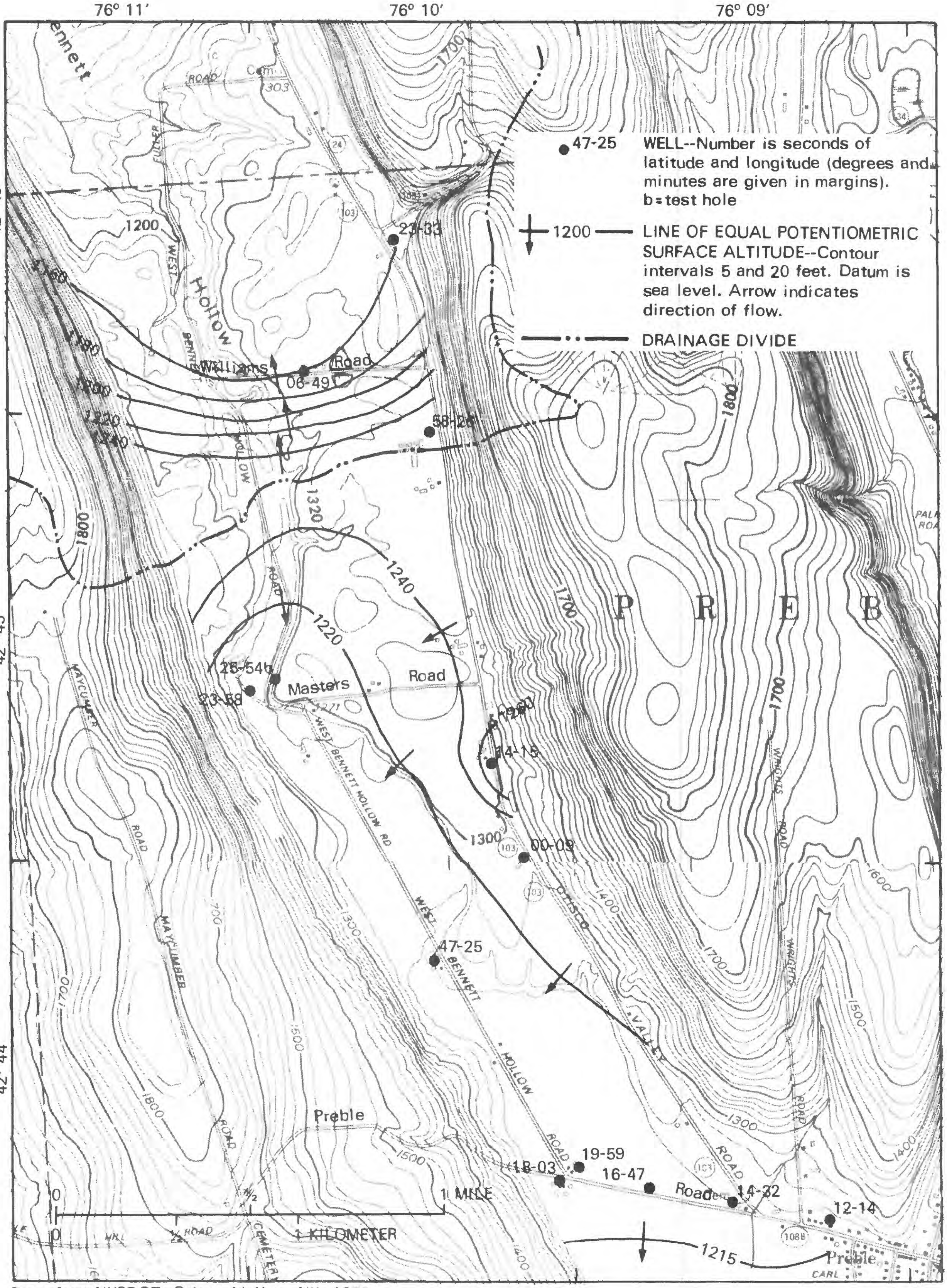


Figure 26A.--Surficial geology of Preble dry valley.



Base from NYSDOT, Otisco Valley, NY, 1978
and Homer, NY, 1974, 1:24,000

Figure 26B.--Potentiometric surface and well and test-hole locations in Preble dry valley.

1. Domestic wells at four of five locations were drilled through ice-contact deposits to the top of bedrock or into bedrock because reportedly no adequate water supply was obtained at lesser depth, even though the owners recalled that the materials penetrated were gravelly.

2. Topographic maps show several swamps, ponds, and a spring in shallow depressions in ice-contact deposits, which suggests that poorly permeable materials, perhaps a till layer, may be present at shallow depth near the divide (Williams Road). Hollyday (1969, fig. 5) estimated the saturated aquifer material near the divide to be only 10 to 40 feet thick.

3. Potentiometric contours are farther apart downvalley to the southeast than near the divide (fig. 26B). Because the volume of ground water moving southeastward must increase downgradient, the wider contour spacing means greater hydraulic conductivity. The steep potentiometric contours shown north of the divide are based on a reported water level in one well penetrating bedrock; they do not coincide with the water table (as the contours south of the divide appear to do) but may represent northward ground-water flow if that flow north of the divide is chiefly through till and bedrock.

Evaluation.--Test drilling could probably locate some permeable layers capable of supporting large-yield wells in ice-contact deposits as well as in the outwash. However, the chances of penetrating sand or gravel capable of yielding several hundred gallons per minute to individual wells are better south of Masters Road than farther north. Hollyday (1969, table 1) estimated that hypothetical wells designed for efficiency could obtain a median yield of 1,300 gal/min in the southern part of Preble dry valley. Wells along the valley axis between Masters Road and Preble Road could undoubtedly capture the annual ground-water yield from the valley. However, some combination of test-pumping exploratory wells and modeling the aquifer would be required to demonstrate whether seasonal withdrawals from wells concentrated at the south end of the valley could efficiently tap the large volume of water stored underground.

Large-scale seasonal pumping would lower water levels and reduce yields in existing wells. Otherwise, such withdrawal of ground water from storage would cause no hydrologic problems because the valley has no wetlands, ponds, or streams.

Caroline

Valley setting.--The through valley at Caroline lies on the Tompkins-Tioga County border (figs. 2, 27) and drains into West Branch Owego Creek, which enters from the north side and turns east into a narrow valley on its way to the Susquehanna River. The headwater reach is relatively small, about 0.9 mile wide and 1 mile long from the divide to West Branch Owego Creek. Drainage west of the divide enters Sixmile Creek, which flows to Cayuga Lake at Ithaca.

Surficial geology.--Stratified drift in the Caroline valley is the product of abundant meltwater flow. Poorly sorted ice-contact deposits (fig. 27) form hummocky terraces at several places along the north wall of the through valley

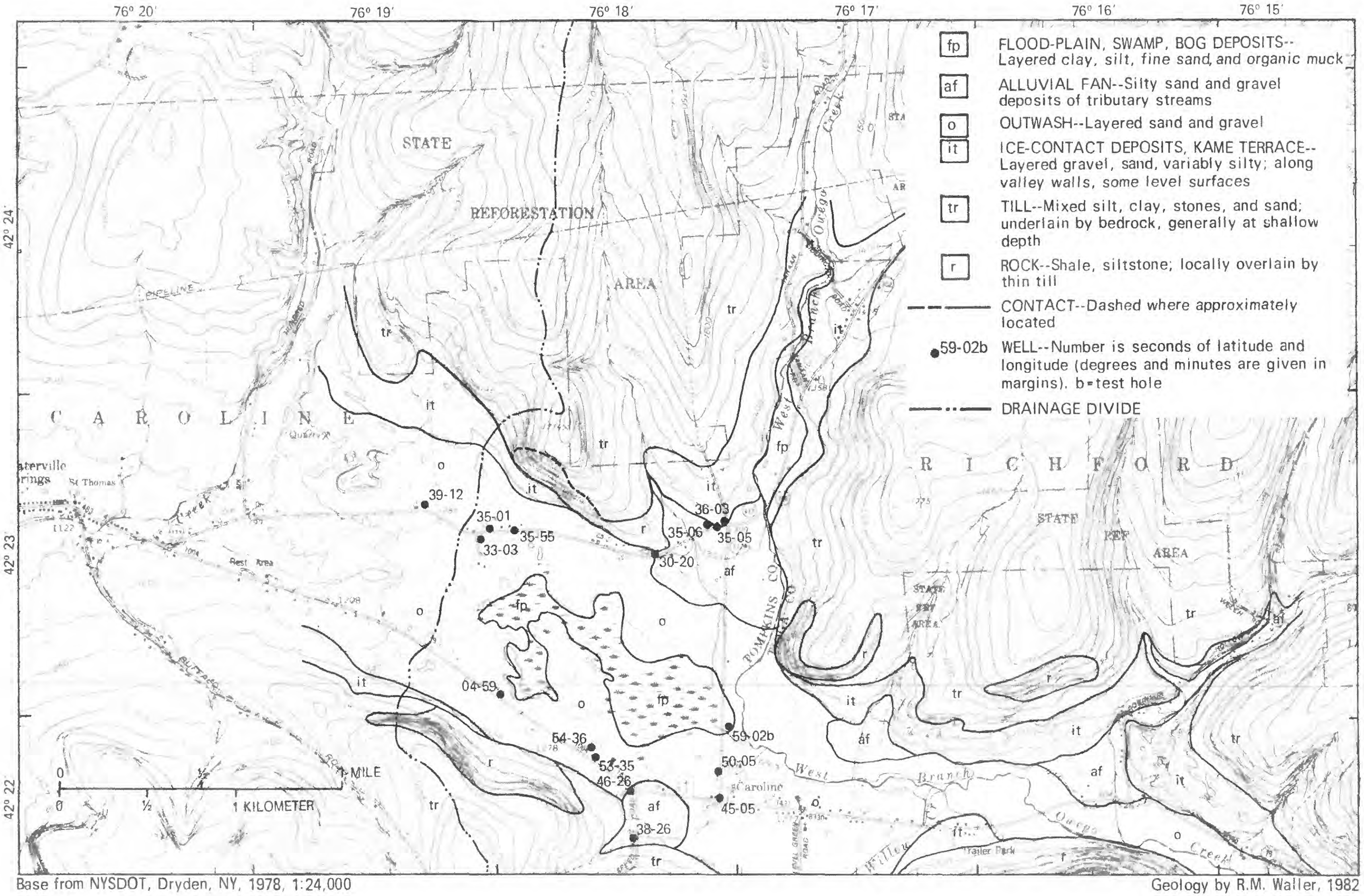


Figure 27.--Reconnaissance map of Caroline valley showing surficial geology, and well and test-hole locations.

and choke the valleys of north-side tributaries. Soils maps (Neeley, 1965; Austin, 1953) suggest that some terraces are capped by till, which may have slumped from adjacent hillsides as described by Denny and Lyford (1963). These meltwater terraces reach altitudes of 1,450 to 1,400 feet above sea level. Subsequent meltwater streams developed lower profiles and built the valley train, which slopes east from 1,290 feet altitude near the divide. Neither well records (table 7) nor soils maps provide evidence of any extensive proglacial lake before deposition of the valley-train outwash; apparently the delivery of sediment by meltwater kept pace with melting of the ice. Silty gravel and localized lenses of clay and silt are common, however. The outwash is at least 70 feet thick and may be as much as 200 feet thick locally. A few wells along Speed Road near the divide reportedly penetrate bedrock within 40 feet of land surface, which suggests a submerged bedrock bench on the north side of the through valley.

Outwash underlies the entire valley floor, although much of the area below 1,270 feet altitude west of Flatiron Road may have a few feet of silt, clay, and organic muck overlying the outwash (fig. 27). Also, tributaries have deposited low-gradient alluvial fans onto the valley floor. Thin till covers the steep bedrock hills along both sides of the valley.

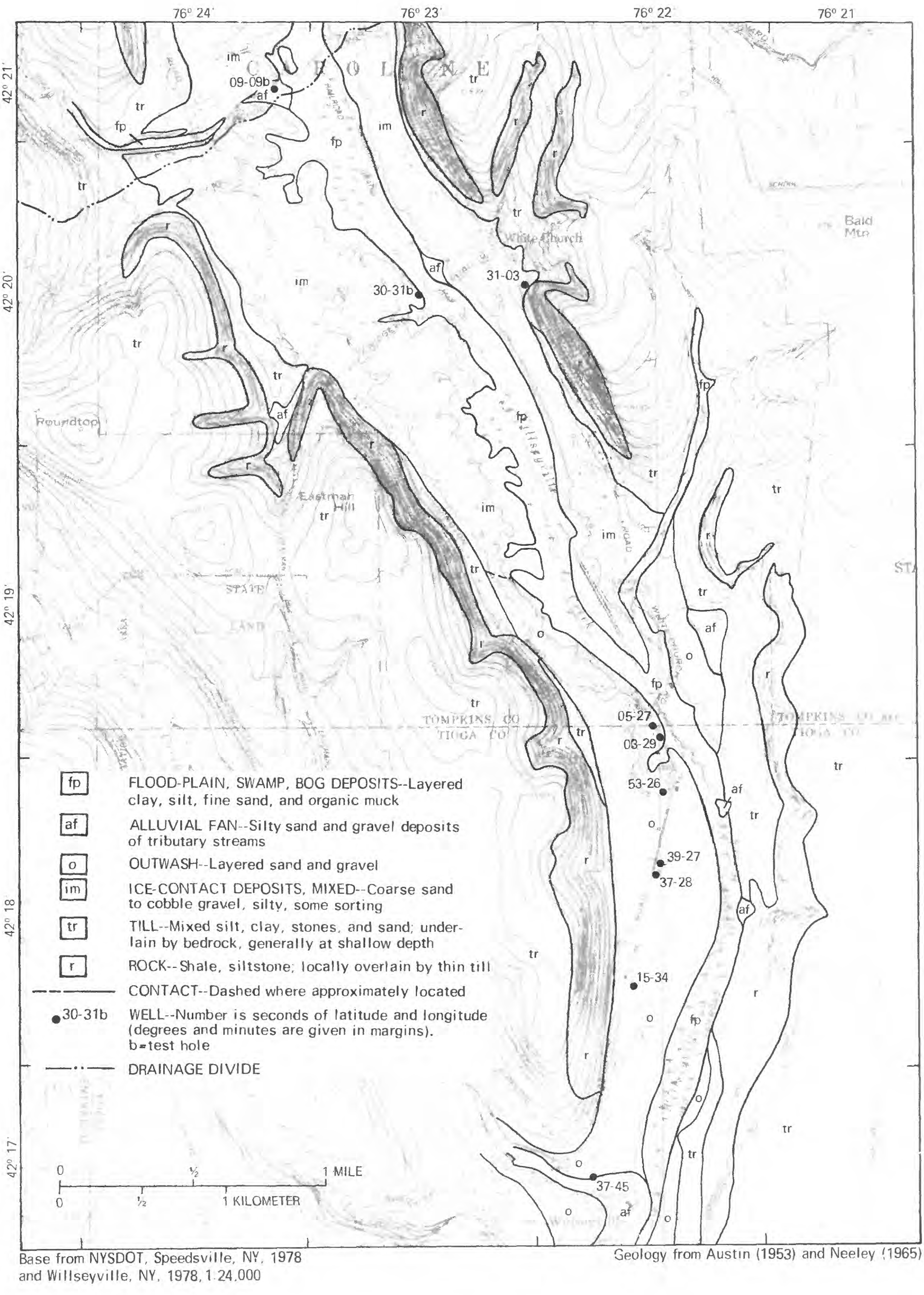
Hydrology.--West Branch Owego Creek probably loses water to its alluvial fan east of Flatiron Road but was still flowing continuously in this reach in September 1982, after a relatively dry summer, when all of its tributaries had stopped flowing at the heads of their alluvial fans.

The well data (table 7) indicate a coarse, variably silty gravel and sand aquifer beneath the entire floor of the through valley. The deposits in the eastern two-thirds of the valley, are saturated to, or nearly to, land surface. Only near and west of the divide is the water table likely to be more than 20 feet below land surface.

Evaluation.--Development of a seasonal ground-water pumping regime appears feasible. The valley floor is underlain by a surficial aquifer whose saturated thickness probably far exceeds 40 feet except perhaps west of the divide and north of Speed Road. Extensive pumping from the headwater reach west of Flatiron Road would probably dewater the wetlands and might diminish flow of small westward-flowing tributaries to Sixmile Creek. Part or all of the small flow of West Branch Owego Creek at Caroline would be lost to induced infiltration, and some reduction in water level and yield could be expected in wells at Caroline.

Willseyville Creek

Valley setting.--This narrow north-south through valley in Tompkins and Tioga Counties (figs. 2, 28) is confined between steep 600-foot-high bedrock hills. It has a maximum width of 0.75 mile at the divide and is only 0.25 mile wide at its outlet, 5 miles south of the divide at Willseyville hamlet. Willseyville Creek drains southward into Catatonk Creek. Drainage north of the divide enters Sixmile Creek leading to Cayuga Lake at Ithaca.



Base from NYSDOT, Speedsville, NY, 1978 and Willseyville, NY, 1978, 1:24,000

Geology from Austin (1953) and Neeley (1965)

Figure 28.--Reconnaissance map of Willseyville Creek valley showing surficial geology, and well and test-hole locations.

The northern part of the valley floor is hummocky and contains much swampland. The southern part consists of a level terrace into which the creek is entrenched about 60 feet. No tributaries drain more than 1 square mile.

Surficial geology.--Stratified drift underlies the entire valley floor (fig. 28). Ice-contact drift predominates near the divide and grades southward into outwash. The numerous small swamps and lakes in the ice-contact deposits far above creek grade indicate widespread till or lacustrine sediment at shallow depth. A former meltwater channel runs the length of the valley; it is deeply entrenched below the surface of the outwash, but the ice-contact deposits on the west side of the channel near the divide are low and hummocky as a result of slumping of ice-supported drift after the channel was cut. The channel is mapped as flood plain because several feet of alluvial silt and organic muck have accumulated on its floor. The outwash adjacent to the channel in Tioga County may be less than 100 feet thick. Two wells near the center of the valley (37-28 and 39-27, fig. 28) were reported to reach bedrock at depths of 80 and 85 feet. No records indicating depth to bedrock were obtained between the county line and the divide, but the northward increase in valley width and records of a few wells north of the divide (Crain, 1974) suggest that the depth to bedrock may increase northward. Thus, the bedrock surface may rise to a saddle near the narrowest part of the through valley, which was probably the preglacial divide.

Greater depth to bedrock near the present divide need not imply greater thickness of sand and gravel. Two test holes (30-31b and 09-09b, fig. 28) in the area of ice-contact deposits penetrated 71 and 32 feet, respectively, of silty alluvium and stratified sand or gravel, then chiefly fine-sandy silt and till.

Hydrology.--Willseyville Creek is perennial and originates in a pond and swamp just south of the divide. Several small intermittent streams drain the steep till-covered walls and provide limited recharge to the valley-fill deposits. The deeply incised meltwater channel permits the upper part of the adjacent stratified deposits to drain readily. Reported water levels in several wells indicate the water table to be only slightly above creek grade. Consequently, the saturated thickness of permeable sand and gravel may be only 25 feet in the southern part of the valley, and commonly even less to the north, although in some low-lying localities more than 40 feet of sand and gravel may have slumped to positions below creek grade (as at test hole 30-31b). The meager data suggest no deeper buried aquifer system.

Discharge of Willseyville Creek was evaluated near Willseyville by Ku and others (1975, p. 105). Surface discharge was estimated to be at least 1 ft^3/s 95 percent of the time and at least 0.7 ft^3/s under virtually all natural conditions. Total basin yield would also include unmeasured underflow.

Evaluation.--Because saturated thickness is generally small, detailed study would be required to determine if and where seasonal development of large supplies of ground water may be feasible. Such development would have little effect on northward-draining streams but would reduce the flow of Willseyville Creek. Therefore, if maintenance of perennial flow in Willseyville Creek in most of the through valley were important, the potential of this valley would be limited.

Pony Hollow

Valley setting.--Pony Hollow lies in Tompkins and Schuyler Counties southwest of Ithaca (figs. 2, 29). Its lower end joins the lower end of the Alpine through valley, discussed in the next section. Pony Hollow is 4 miles long and nearly 0.4 mile wide throughout its length. The valley floor is nearly flat and is bordered by bedrock hills 600 feet high.

Pony Hollow Creek flows southwestward along the valley axis. Only two tributaries, Carter Creek from the north and Chaffee Creek from the south (fig. 29), drain more than 2 square miles of upland. Drainage northeast of the through valley divide is to West Branch Cayuga Inlet.

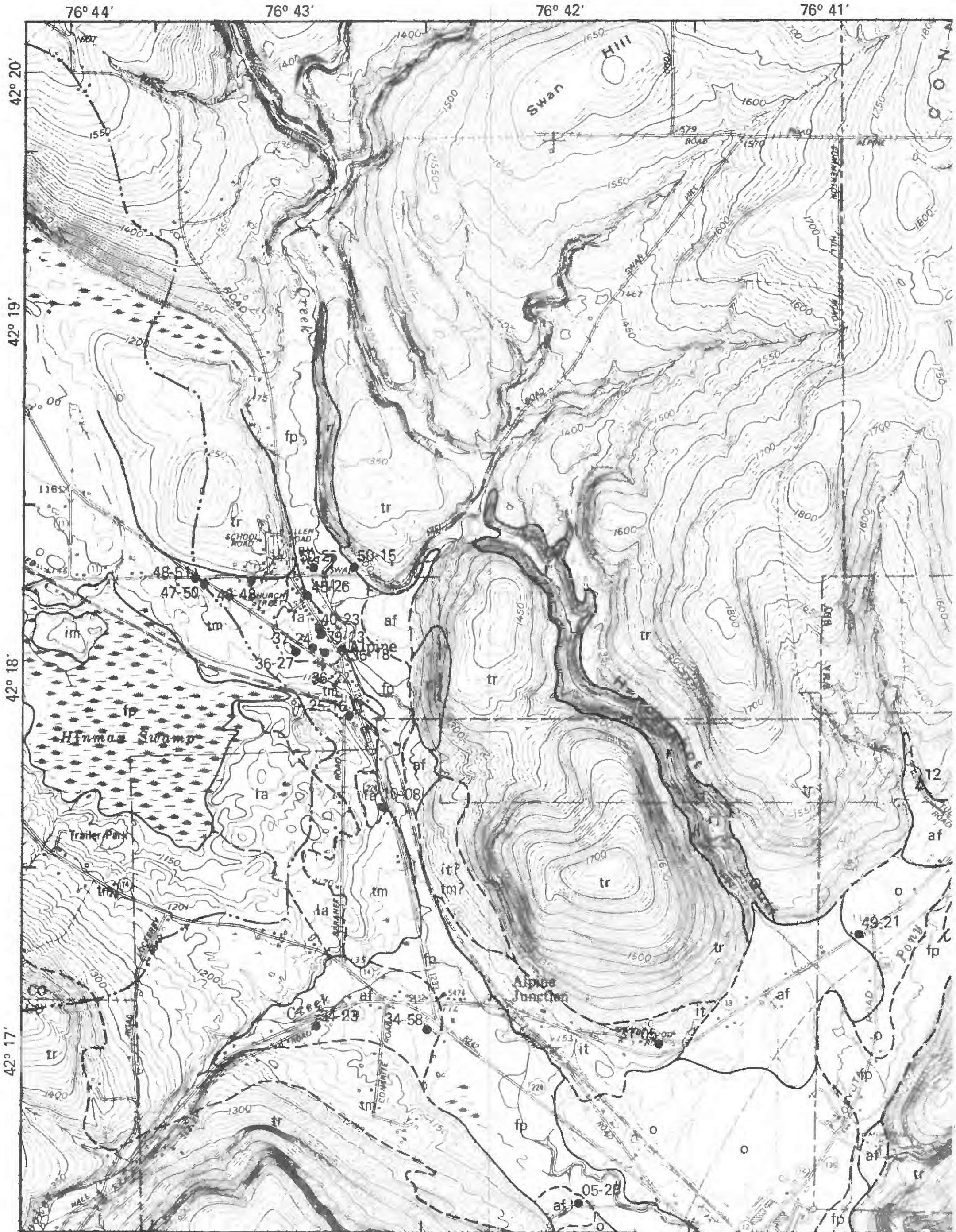
Surficial geology.--A valley train of outwash was laid down in Pony Hollow by meltwater issuing from an ice front near the present drainage divide. The irregular topography north of the divide reflects melting of buried ice after outwash deposition ceased. Tributaries built alluvial fans into the outwash and subsequently atop it. Fans from opposite sides of the valley probably coalesce locally. The present master stream has laid down a thin cover of silty flood-plain deposits.

Well and test-boring records (table 7) indicate that throughout the valley, the alluvial fan or outwash gravels extend to a depth at least 40 feet below the water table, which is close to land surface. Total thickness of stratified drift is known to exceed 85 feet near the divide and 60 feet down-valley and may be substantially greater. Two records suggest silty fine sand beneath the outwash, but in general the character of the valley fill below a depth of 40 to 60 feet is unknown.

Hydrology.--Streamflow at several sites along Pony Hollow Creek and its tributaries was determined on four dates in 1981 and 1982 during periods of base flow. Some sites were chosen at the edge of the valley, where tributary channels are on till or bedrock; those measurements represent total inflow to Pony Hollow from their respective upland basins on the dates of measurement. Sites are shown in figure 29; results are listed in table 6. Some tentative conclusions can be drawn from these data.

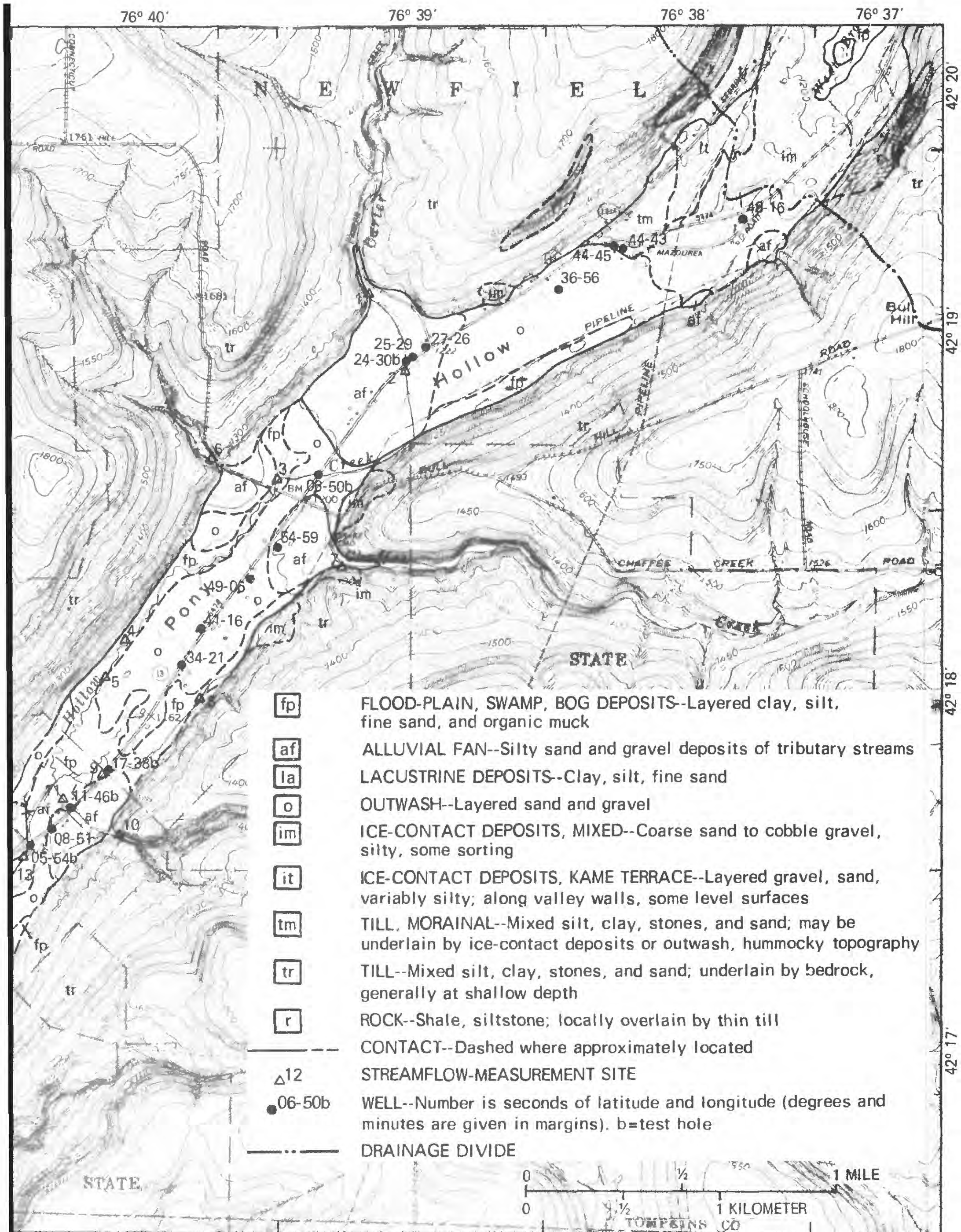
1. Seepage losses from tributary streams are a substantial source of recharge. On May 5, 1981, seepage losses were about 4 ft^3/s, even though flow had probably been declining for 6 days after the last major storm. Seepage losses during periods of rising and peak stream stage may be appreciably greater. Water levels measured or reported for wells in Pony Hollow on various dates (table 7) suggest that the water table reaches its highest altitude near Carter Creek. Even though runoff from the south valley wall during the spring freshet flows westward from the topographic divide on the valley floor (fig. 29), recharge by seepage from Carter Creek may control the position of the ground-water divide.

2. The stratified drift is quite permeable for about 2 miles downstream from Carter Creek. Despite substantial seepage loss from tributaries, recharge from precipitation, and runoff from adjacent hillsides, Pony Hollow Creek received little ground-water discharge upstream from the 1,150-foot contour; underflow must have been several cubic feet per second.



Base from NYSDOT, Alpine, NY. 1978, 1:24,000

Figure 29.--Reconnaissance map of Alpine valley and Pony Hollow valley showing



Geology by T.J. Holecek, 1981 and P.S. Murdoch, 1982

surficial geology, and well and test-hole locations, and stream-measurement locations.

Table 6.--Streamflow measurements in Pony Hollow.
[Measured flows in cubic feet per second; dashes indicate site not visited on that date.]

Date	Measurement site (locations shown in fig. 29) 1	2	3	4	5	6	7	8	9	10	11	12	13	Estimated long-term flow duration[a]
1981														
May 5 [b]	6.13	Flowing [c]	5.14	5.14	--	.94	3.06	1.09	Flowing	1.68	1.54	.63	13.2	30
July 16	.71	Goes dry 200 ft downstream	Dry	Dry	.08 [d]	--	.17	Dry	Pools	--	.05 (est.)	--	3.22	73
1982														
June 10 [e]	6.74	Flowing	6.61	7.54	Flowing	[f]	4.09	2.73	Flowing	--	2.44	--	20.4	25
July 27	.29	Goes dry here	Dry	Dry	Dry [g]	--	.06	Dry	Pools	--	Pools	--	2.99 [h]	78
Sept. 22	--	Dry	Dry	--	--	--	--	--	Pools	--	Dry	--	Flowing	--

a Based on estimated flow duration through 1967 for Carter Creek at site 1 (Ku and others, 1975, p. 107) and correlation with flow duration 1939-72 of Cayuga Inlet near Ithaca (U.S. Geological Survey, unpub. records).
b Last rain 0.8 inches April 29, 0.3 inches or more April 23 after long dry period.
c 1,200 feet downstream, a tiny fraction of flow turned left and accumulated in depression 2,000 ft northeast.
d Flow resumed 300 ft upstream, was intermittent for 600 ft downstream.
e Rainfall of 2.2 inches June 2-6 at Ithaca, N.Y.
f Flow reaches Pony Hollow Creek, not measured.
g Flow resumed 300 ft downstream; flow 0.06 ft^3/s 800 ft downstream.
h Flow 2.79 ft^3/s 1 mile downstream.

3. Ground-water discharge of 3 to 6 ft^3/s enters Pony Hollow Creek throughout the summer in the last 1,500 feet upstream from site 13; the channel upstream and possibly downstream from this reach is commonly either losing water or dry. This concentrated discharge must result from some combination of recharge within this reach and reduced water-transmitting capacity downstream. Even if the water-transmitting capacity of the stratified drift were the same at all points along Pony Hollow, discharge to the stream would begin somewhere because the cumulative increase in recharge downvalley would eventually exceed the amount of ground water that could be transmitted as underflow. Consideration of measurements at sites 10-12 on May 5 (table 6) and regional average recharge rates (MacNish and Randall, 1982) suggests, however, that recharge from seepage and precipitation within this 1,500-foot reach is unlikely to exceed 2 ft^3/s, much less than the observed increases in streamflow. Flow measured at site 13 on July 27 was twice that predicted for the 78-percent flow duration from regional analysis (Ku and others, 1975, p. 38, appendix A), which suggests that underflow here may be small relative to that in other valleys. Borehole records do not suggest any decrease in saturated thickness of surficial gravel near site 13, but a decrease in average permeability due to presence of silty alluvial-fan deposits is conceivable, and till, lacustrine silt, or shallow bedrock may be present locally beneath the gravel. This reasoning seems to support a hypothesis of thinner or less permeable valley fill near site 13, but further study would be needed to verify the hypothesis.

Evaluation.--Although Pony Hollow is narrow and thus contains less ground-water storage than many through valleys, the combination of 40 feet or more of surficial saturated gravel and a 3-mile headwater reach without surface flow in dry weather should permit seasonal ground-water withdrawals with minimal impact on streamflow downvalley. Development downvalley from site 4 (fig. 29) would reduce and might eliminate low flow of Pony Hollow Creek at site 13, which is about 3 ft^3/s at 75- to 80-percent flow duration (table 6) and less under very dry conditions. If the water-transmitting capacity of the valley fill is indeed low near site 13, the cone of depression resulting from heavy seasonal ground-water development upstream would probably not extend far downstream and thereby avoid effects downstream other than the flow reduction mentioned. More information is needed on thickness and water-yielding properties of the valley fill, particularly below the top 40 feet.

Alpine

Valley setting.--The Alpine through valley is in the southeast corner of Schuyler County and joins Pony Hollow at their respective downvalley ends (figs. 2, 29). The Alpine through valley is unusual in that drainage northward from the divide follows a broad, gently sloping upland valley for about 4 miles rather than descending abruptly into a deeply incised valley. The headwater reach south of the divide is only 1.5 miles long.

Cayuta Creek, the principal stream, enters the valley from the bedrock hills to the north and occupies a meltwater channel along the east side of the valley. Hooker Creek, entering from the southwest, is the only significant tributary. A large wetland, Hinman Swamp, lies northwest of the drainage divide and may discharge in both directions under high-water conditions.

The hamlets of Alpine, near the drainage divide, and Cayuta, at the junction of Alpine and Pony Hollow through valleys, obtain domestic water supplies from individual wells.

Surficial geology.--Alpine valley probably contains thinner drift and less outwash than most through valleys. The north-south valley now occupied by Seneca Lake and Catherine Creek, west of Alpine, was greatly deepened by rapid flow within the ice sheet and accumulated a great thickness of fine-grained stratified drift during deglaciation. By contrast, the equally broad valley trending southeast from Seneca Lake to Alpine was less deeply eroded, and the drift may be relatively thin in most places. The divide at Alpine crosses a large mass of drift (a moraine) whose thickness and lithology are poorly known. Till and lacustrine silty clay form the surface of the moraine (fig. 29), but a few wells end in sand and gravel at depths of 20 to 40 feet (table 7). In several through valleys, till at land surface near the divide is only a thin layer and overlies outwash gravel that continues downvalley beyond the till. At Alpine, however, some evidence suggests the valley was never filled with outwash. Most meltwater apparently followed and eroded the spectacular channels in the uplands just north of Alpine hamlet. The valley floor south of the moraine is lower than the valley train in Pony Hollow where the two valleys join, which suggests less sediment influx. The size and location of Hinman Swamp imply that meltwater ceased to flow down Alpine valley long before the last ice block melted.

Hydrology.--Cayuta Creek is apparently perennial throughout its traverse of the through valley. In September 1982, however, after a dry summer, the creek contained very little flow south of Alpine. At the same time, Hooker Creek was dry at its mouth.

The water table is near land surface over most of the valley floor, as shown by well records (table 7) and the presence of numerous small swamps. The alluvial fan and ice-contact complex near Hooker Creek probably has a water table 10 to 20 feet below land surface. Thickness of saturated aquifer material is not well known, however.

Hooker Creek provides significant recharge to the aquifer, as do precipitation and runoff from adjacent hillsides.

Evaluation.--The Alpine through valley seems less than ideal for seasonal ground-water development. The reach from divide to valley mouth is only 1.5 miles long and is traversed by Cayuta Creek, whose flow (from 30 square miles) might easily be captured by induced infiltration. Ground-water development in the morainal area near and west of the divide might have little effect on Cayuta Creek but would probably lower the water level in Hinman Swamp and might adversely affect the swamp ecosystem. Furthermore, neither exposures nor well records suggest extensive permeable sand and gravel in this area, and the till and lake deposits at land surface may limit recharge. Hollyday (1969, table 1) estimated average yield of hypothetical screened wells in morainal deposits in the Susquehanna basin to be 260 gal/min.

Beaver Dams

Valley setting.--The Beaver Dams through valley (figs. 2, 30) extends north-south about 2 miles in southern Schuyler and northwestern Chemung Counties. The valley is about 0.75 mile wide at the divide but narrows to about 0.50 mile downvalley. Shale bedrock hills 500 to 600 feet high flank the valley; their slopes become steeper in the southern part.

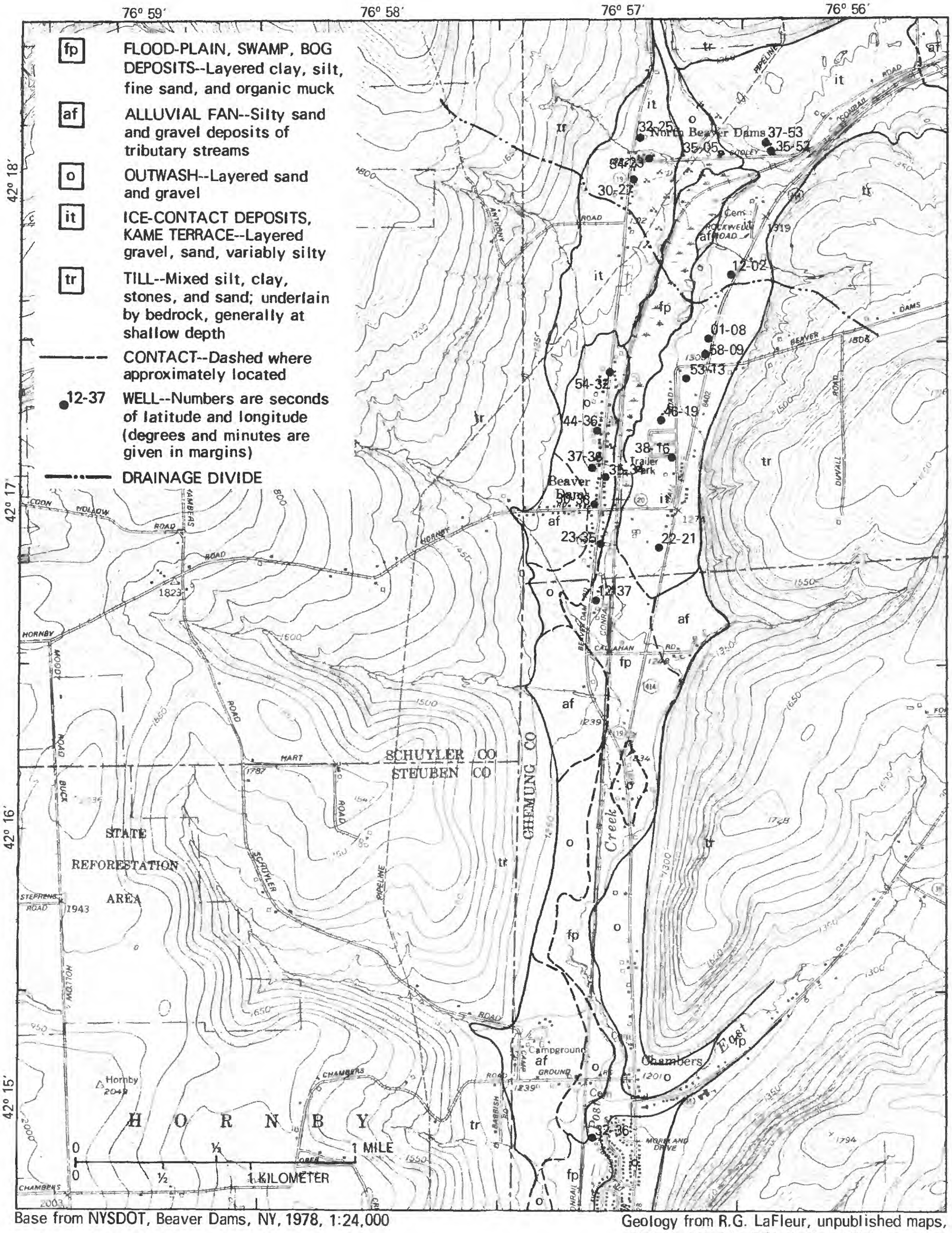
A narrow mile-long wetland lies astride the divide along the valley axis. Post Creek heads in the wetland and flows south. Drainage north of the divide flows east to Seneca Lake through Shequagua Creek, which is not deeply incised.

Surficial geology.--Stratified drift in the Beaver Dams through valley was deposited by meltwater flowing from the northeast along the through valley and from the north along a narrow gorge that also cuts through the preglacial divide. Most stratified drift north of the Schuyler-Chemung County line was laid down beside or on blocks of stagnant ice and is mapped as ice-contact kame terraces; the terraces grade downvalley into outwash. Well records from north of the county line suggest that both ice-contact deposits and outwash consist largely of sand and gravel. After meltwater flow ceased, melting of ice blocks created depressions along the valley axis near and northeast of the divide. Sand and gravel that had been deposited atop former ice blocks collapsed when the ice melted and may now underlie the margins or possibly all of the wetland near the divide, beneath silt and organic deposits. Tributary streams built alluvial fans atop the outwash.

Hydrology.--Post Creek probably is perennial from the wetlands downvalley, although north of Chambers its flow was very small in September of both 1980 and 1982. Tributary streams are generally dry in late summer downstream from the valley walls.

All 22 wells inventoried in Beaver Dams through valley (table 7) probably obtain water from stratified drift. Many are finished only 10 or 20 feet below the grade of Post Creek, but several penetrate 30 to 50 feet below creek grade. No wells overflow, all water levels are close to creek grade, and no wells are reported to have inadequate yields or to have penetrated fine-grained materials. Thus, it appears that the entire headwater reach is underlain by a permeable sand-and-gravel aquifer with a saturated thickness of at least 40 feet.

Evaluation.--The aquifer has excellent potential for large well yields and could be developed on a seasonal basis, although maximum aquifer thickness is as yet unknown. Large-scale seasonal withdrawals north of the county line would adversely affect the yield of the numerous shallow domestic wells in this reach. Such withdrawals would probably have only a minimal effect on streamflow because the low flows of Post Creek and Shequagua Creek, which drain from this reach, are already quite small.



Base from NYSDOT, Beaver Dams, NY, 1978, 1:24,000

Geology from R.G. LaFleur, unpublished maps, 1966; modified by R.M. Waller, 1982

Figure 30.--Reconnaissance map of Beaver Dams valley showing surficial geology, and well and test-hole locations.

Valley setting.--The through valley at Bath is a short, broad valley in central Steuben County (figs. 2, 31). The valley's length is about 1.5 miles, and its width increases from 1 mile near the divide to 2 miles near the Cohocton River valley. The city of Bath and suburbs occupy part of the area, but the city is predominantly in the Cohocton valley. The valley floor has several kettle lakes but no perennial streams. Cold Brook, fed by springs north of the divide, descends northward to Keuka Inlet, which flows to Keuka Lake. Bedrock hills adjacent to the valley rise 400 to 500 feet above the valley floor.

Surficial geology.--The upper part of the valley fill is predominantly outwash (fig. 31); kame terraces and alluvial fans flank the valley margins. The numerous kettles and the undulating land surface indicate ice downwasting and suggest that meltwater deposits may have a complex structure.

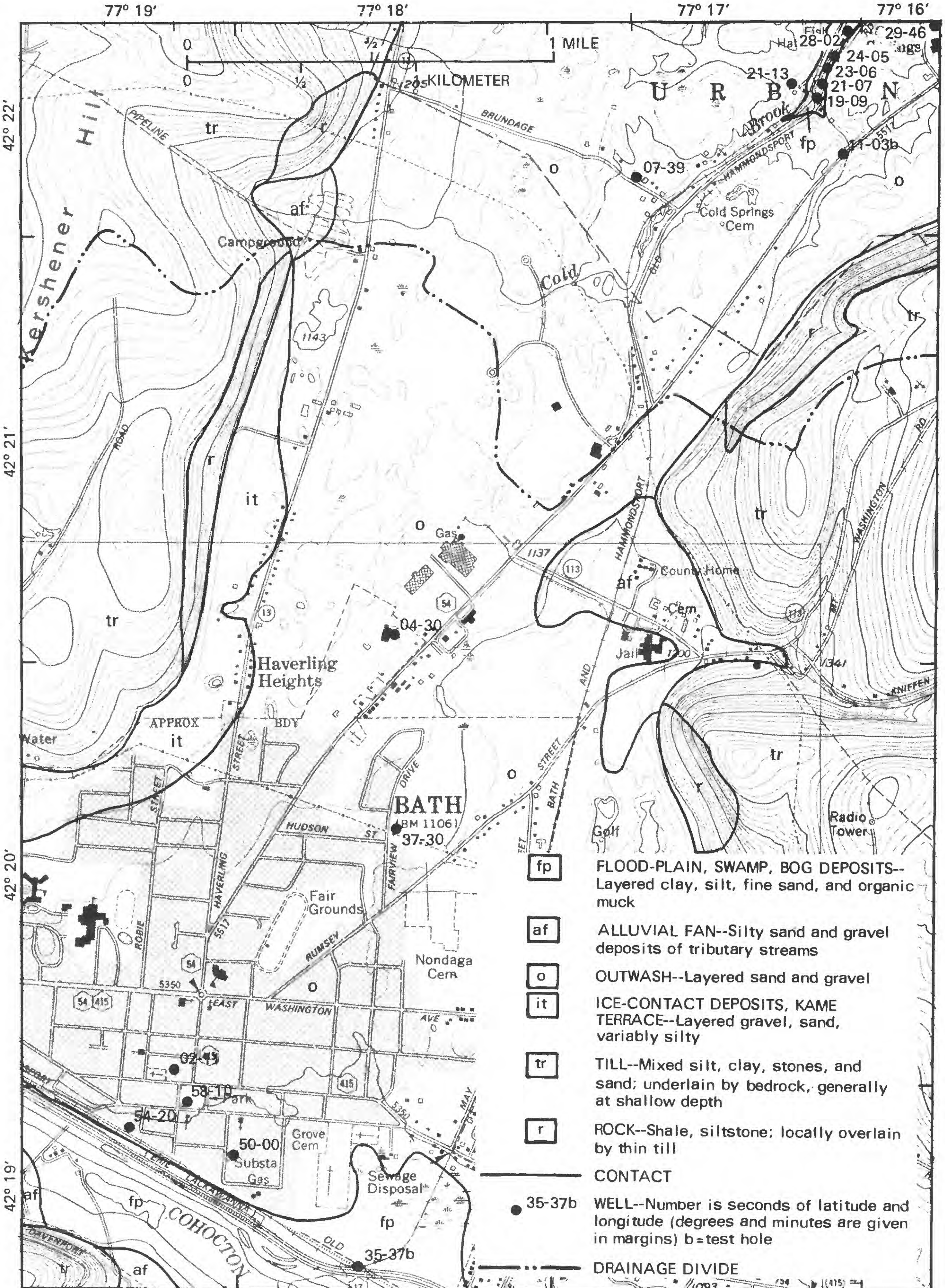
Well data (table 7) indicate that the outwash sand and gravel has significant clay content in the upper few feet and is 20 to 90 feet thick. A lacustrine sequence lies beneath the outwash and may be interbedded with clayey till near the divide. Lacustrine clay, fine silty sand, and perhaps till extend to a depth of 300 feet or more at the State fish hatchery north of the divide. More than 80 feet of clay in the center of the Bath through valley grades southward into very fine sand in the Cohocton valley. A dirty sand and gravel as much as 65 feet thick underlies the lake deposits in the southern part of Bath, but how far northward the sand and gravel may extend is unknown. The greatest known thickness of valley-fill deposits is 175 feet, which was penetrated in downtown Bath by a well that did not reach bedrock.

Hydrology.--The Bath through valley is basically a dry valley south of the divide. It has no significant tributary valleys. All recharge to the valley fill comes from direct precipitation and runoff from the hills.

MacNish and Randall (1982) considered the surficial aquifer to be more than 40 feet thick in the Bath through valley and less than 40 feet thick in the Cohocton River valley; they also recognized a confined aquifer more than 100 feet below land surface in the Cohocton valley. Water levels measured in three water-table wells in Bath ranged from 5 to 29 feet below land surface. Most of the lake-water levels are less than 20 feet below adjacent land surface also and probably represent the water table.

The surficial aquifer north of the divide is contiguous with that to the south and discharges into Cold Brook and its tributaries. A flowing well at the State fish hatchery along Cold Brook indicates deeper, confined aquifers.

Evaluation.--The city of Bath is ideally located for large year-round ground-water development with minimum effect on streamflow. The Bath through valley could just as well have been classified as a "separated valley" (see section "Aquifers that may constitute independent water resources, p. 3") because it abuts the Cohocton valley, which contains a major stream. Large water supplies could probably be developed from the surficial aquifer near the Cohocton River from shallow screened wells whose yields would be sustained by induced infiltration from the river. During periods of low river flow, the



Base from NYSDOT, Bath, NY, 1977, 1:24,000

Geology modified from R.G. LaFleur, unpublished maps, 1966

Figure 31.--Surficial geology and well locations in Bath valley.

riverbank wells could be shut down and alternate wells in the Bath through valley 1 to 2 miles from the river could be pumped instead. For a few months, the yields of the alternate wells would be sustained largely from storage in the aquifer. Local effects of the lowered water levels would probably be slight because the valley has no south-flowing streams and because much of the area is served by a public water system, so presumably the temporary reduction in ground-water storage would affect few wells. Some long-term reduction of the flow of springs north of the divide could be expected. A comparable strategy of alternating seasonal withdrawals from riverbank and offstream wells was proposed for an aquifer in Binghamton, N.Y., by Randall (1977, p. 26).

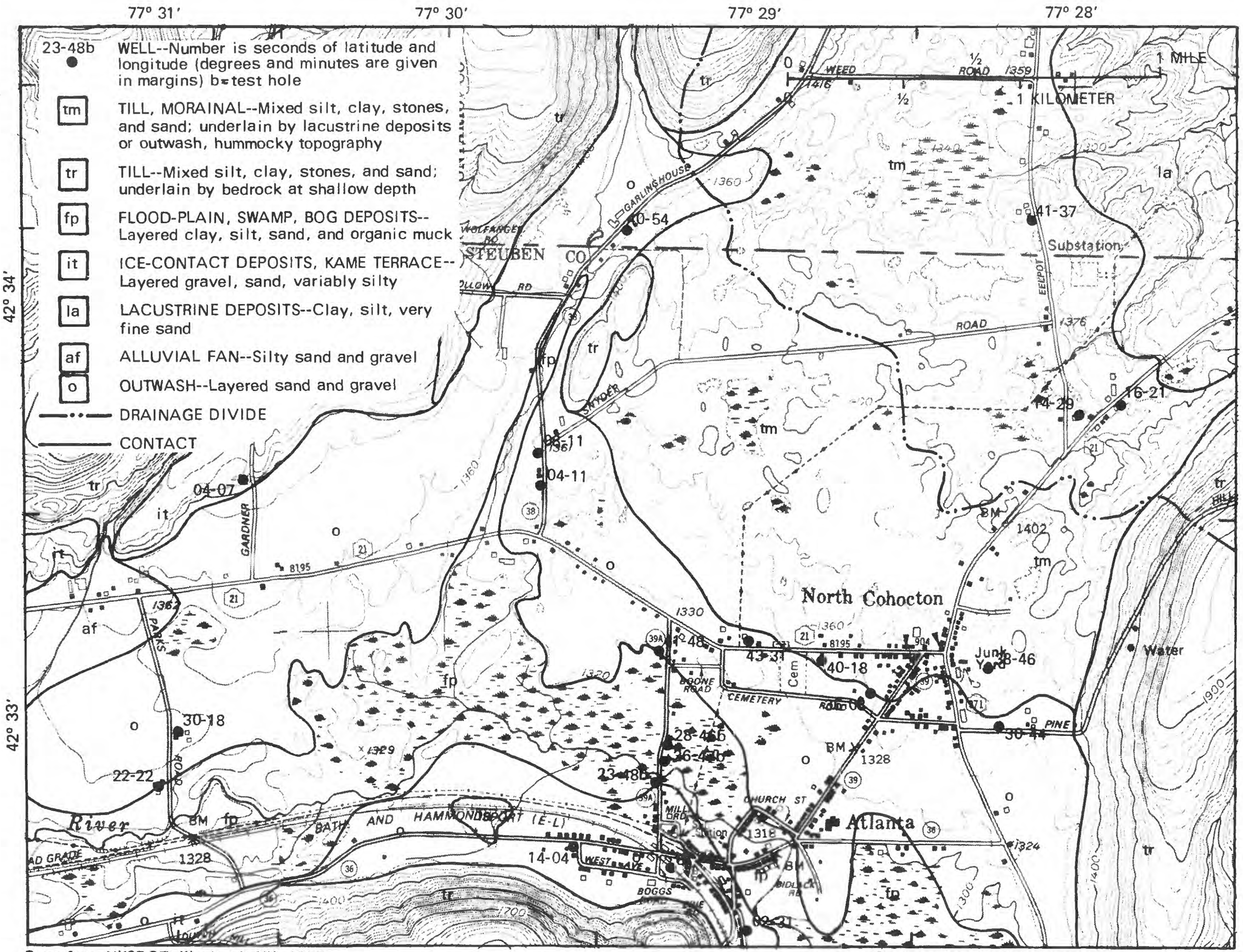
The confined aquifer in the Cohocton valley also is a potential alternative source of ground water in Bath during periods of low river flow. Hollyday (1969, table 1) estimated that hypothetical efficient wells tapping confined aquifers such as this would have a median yield of 1,300 gal/min. However, reasonable estimates of how long the confined aquifer could be pumped before streamflow would be appreciably reduced cannot be made until more is known about the aquifer and the extent, continuity, and vertical hydraulic conductivity of the confining layer.

North Cohocton

Valley setting.--The through valley at North Cohocton drains south into the Cohocton River valley near the junction of Ontario, Livingston, and Steuben Counties (figs. 2, 32). The through valley is 2 miles wide and about 2 miles long. Two small tributaries to the Cohocton River flow south along the west edge of the through valley. The valley floor is characterized by gently sloping hummocky terrain with many small wetlands near the divide, and by low terraces with extensive wetlands near the Cohocton River. The valley walls are 500 to 600 feet high. Drainage north of the divide is to Canandaigua Lake.

Surficial geology.--The hummocky terrain near the divide in North Cohocton valley is capped by at least 10 feet of till (fig. 32) that was deposited from an advance of ice over extensive fine-grained lacustrine deposits that are penetrated by deep wells (table 7). The till is a nonstratified sandy silt to clayey sandy silt with scattered rounded pebbles that constitute 10 to 20 percent of its volume. It is overlapped on the south by extensive outwash that slopes east from Wayland and south from a channel along the west side of the North Cohocton valley. Maximum known drift thickness south of the divide is 265 feet, as indicated by well 38-46 at North Cohocton, which penetrates mostly fine-grained drift. The wetlands probably represent the last stages of a proglacial lake; they contain peat and muck, as much as 17 feet of which were logged in test hole 26-47b northwest of Atlanta.

Hydrology.--The small tributaries draining the western edge of the North Cohocton through valley may lose water where they traverse alluvial fans or outwash. The Cohocton River at the south end of the valley is perennial and represents the base level of the water table. The stratified drift has a large saturated thickness but apparently contains only thin layers of gravel and coarse sand. The maximum known saturated thickness of sand and gravel is 20 feet, which was penetrated at shallow depth by test holes west of Atlanta.



Base from NYSDOT, Wayland, NY, 1977 and Naples, NY, 1977, 1:24,000

Geology from R.G. LaFleur, unpublished maps, 1966; modified by R.M. Waller, 1982

Figure 32.--Surficial geology and well and test-hole locations in North Cohocton valley.

Evaluation.--Wells capable of providing large seasonal ground-water supplies are probably not feasible in the area of morainal till and lacustrine deposits near the divide. Test drilling to depths of 300 feet might disclose scattered prelacustrine deposits of sand and gravel with good aquifer potential. Hollyday (1969, fig. 5) estimated that confined sand-and-gravel aquifers above a depth of 200 feet are less than 10 feet thick but could yield an average of 550 gal/min to properly designed wells. Crain (1974) thought that short-term yields of 5 to 250 gal/min could be expected from wells tapping confined aquifers immediately north of the divide.

Close to the Cohocton River, yields of a few hundred gallons per minute could probably be obtained from wells 20 to 40 feet deep that tap the surficial outwash. Large withdrawals in this area would promptly reduce river flow by induced infiltration, however.

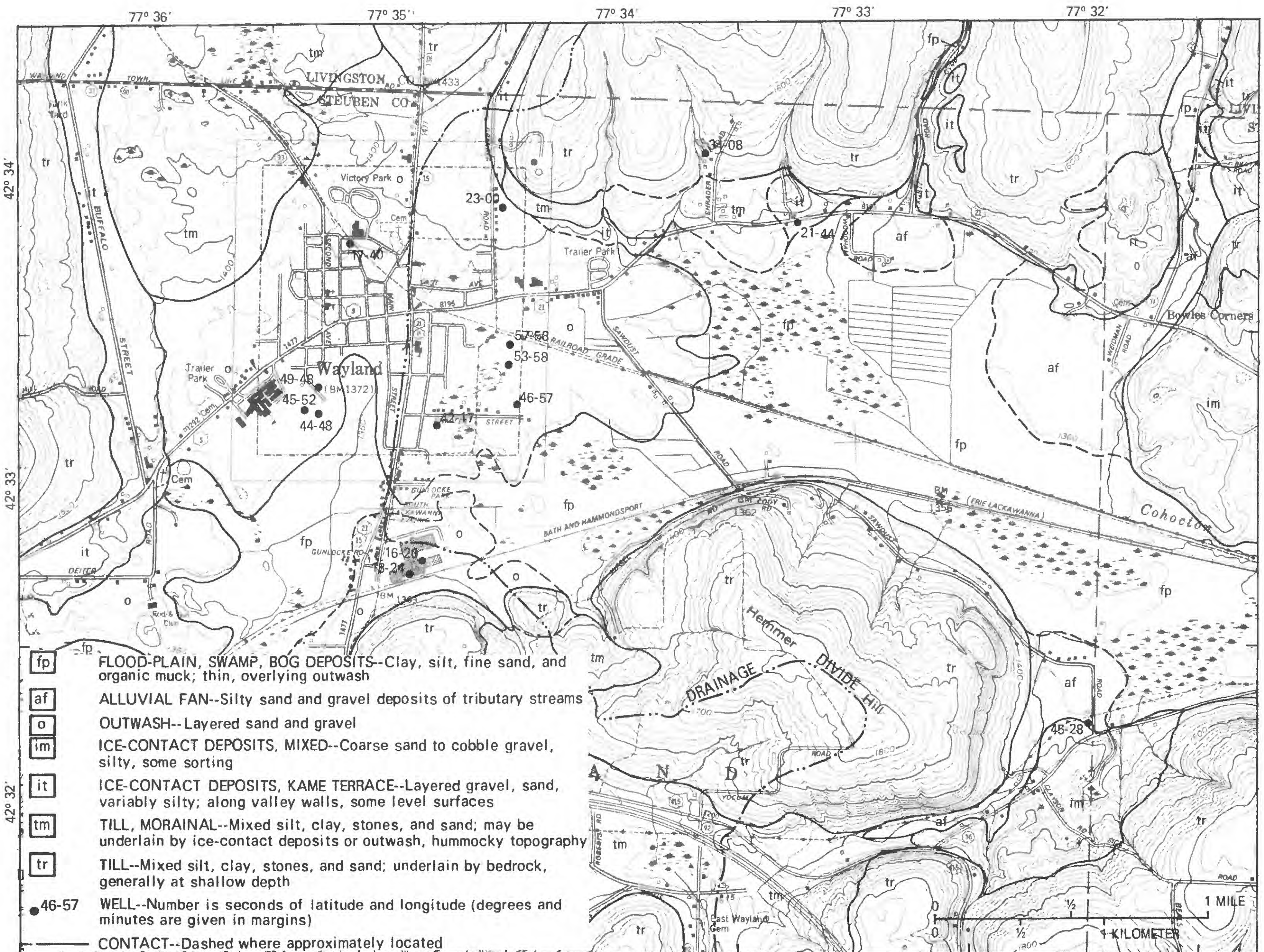
The North Cohocton valley might be classified as a separated valley as well as a through valley for much the same reasons as the Bath valley previously described. However, the relatively small flow of the Cohocton River (drainage area is only about 34 square miles at Atlanta) and the likelihood of small saturated thickness of sand and gravel in the through valley make the potential for alternating seasonal use of riverbank and offstream wells much less than at Bath.

Wayland

Valley setting.--The Wayland through valley is in northern Steuben County (figs. 2, 33) in an area of intersecting through valleys. It drains eastward to the Cohocton River, which enters the valley from hills to the north. The valley floor is about 1.5 miles wide, 2.5 miles long, very flat, and contains large wetlands. From the divide, which passes through the Village of Wayland, broad valleys drain north to Hemlock Lake and west to Canaseraga Creek (fig. 33).

Surficial geology.--The Wayland through valley contains stratified drift that extends at least 85 feet below land surface. The valley-floor surface is outwash with a thin cover of flood-plain deposits in wetland areas (fig. 33). Ice-contact deposits from earlier stages of glaciation cover the lower slopes of the hills; till mantles the upper slopes.

Data from wells (table 7) indicate a history of lacustrine deposition interspersed with outwash deposition in the later stages. During deglaciation, ice tongues west of Wayland, north of Wayland, and north of North Cohocton discharged meltwater into a proglacial lake that occupied the broad valley between Wayland and North Cohocton. Near Wayland, thick blue clay lies 40 to 60 feet below land surface and grades upward into fine sand and silt. At the top are layers of coarse sand and gravel outwash that range from 3 to 28 feet in thickness, separated by clay. The uppermost sand and gravel is silty near land surface. Data downvalley to the east are sparse--only a thin surface outwash (mantled by silty gravel) is known.



Base from NYSDOT, Wayland, NY, 1977, 1:24,000

Geology modified from Mansue and others (in press)

Figure 33.--Reconnaissance map of Wayland valley showing surficial geology and well locations.

Hydrology.--The Cohocton River is small but perennial where it crosses the east end of the through valley. The extensive nearby wetlands indicate a shallow water table. Static water levels in the Wayland village wells, near the divide, were reported to be less than 15 feet below land surface in 1956.

Hollyday (1969, fig. 5) and MacNish and Randall (1982, pl. 1) estimated that the saturated thickness of surficial aquifers in this valley is typically between 10 and 40 feet. Median yield of hypothetical efficient screened wells was estimated to be 1,100 gal/min (Hollyday, 1969, table 1).

Evaluation.--Ground water for seasonal use should be obtainable in the 2.5-mile reach between the divide and the Cohocton River, but large seasonal pumping would lower water levels over part or all of the Wayland through valley. Possible effects of the lowered water levels could include reduced yield of the Wayland well field, reduced flow of the Cohocton River, and reduced evapotranspiration from the large wetlands. Therefore, the optimum location and magnitude of pumping would depend on the extent to which these effects are tolerable or desirable. The thickness and extent of aquifers in the eastern half of the through valley are unknown. Test drilling would be required to evaluate these aquifers.

Burns

Valley setting.--The Burns through valley is in Allegany and Steuben Counties near their junction with Livingston County (figs. 2, 34). The valley is long, more than 4 miles from the divide to Arkport at its south end. Width decreases from 1.5 miles at the north end to about 1 mile at Arkport. The hamlet of Burns lies in the center of the valley.

The valley floor contains large areas of wetland north of Burns and even larger areas of former wetland south of Burns that were drained and are now in intensive agricultural use. Ditches within these drained wetlands constitute the stream system over two-thirds of the valley floor; they drain into the Canisteo River through a control structure at Arkport, near the point at which the river leaves the upland to the west and enters the through valley.

Immediately north of the divide, Canaseraga Creek is incised 200 feet into the valley floor and is fed by numerous springs that drain the north end of the through valley.

Surficial geology.--Kame terraces composed of heterogeneous and commonly silty sand and gravel are banked against bedrock on the valley walls; terrace surfaces are 100 feet or more above the valley floor (fig. 34). The valley floor is underlain everywhere at shallow depth by a layer of outwash sand and gravel 20 to 40 feet thick. Thick clay, silt, and fine sand underlie the outwash, as shown by exposures on the walls of Poags Hole and a few well records (fig. 34; table 7), which suggests that the valley was occupied by a large lake after the ice tongue associated with the kame terraces had melted. After meltwater was diverted elsewhere and outwash deposition ceased, shallow lakes remained and gradually filled in to become a vast muckland. The dark-brown muck on the west side is referred to as "peat muck"; the black muck on the east side is called "cattail muck."

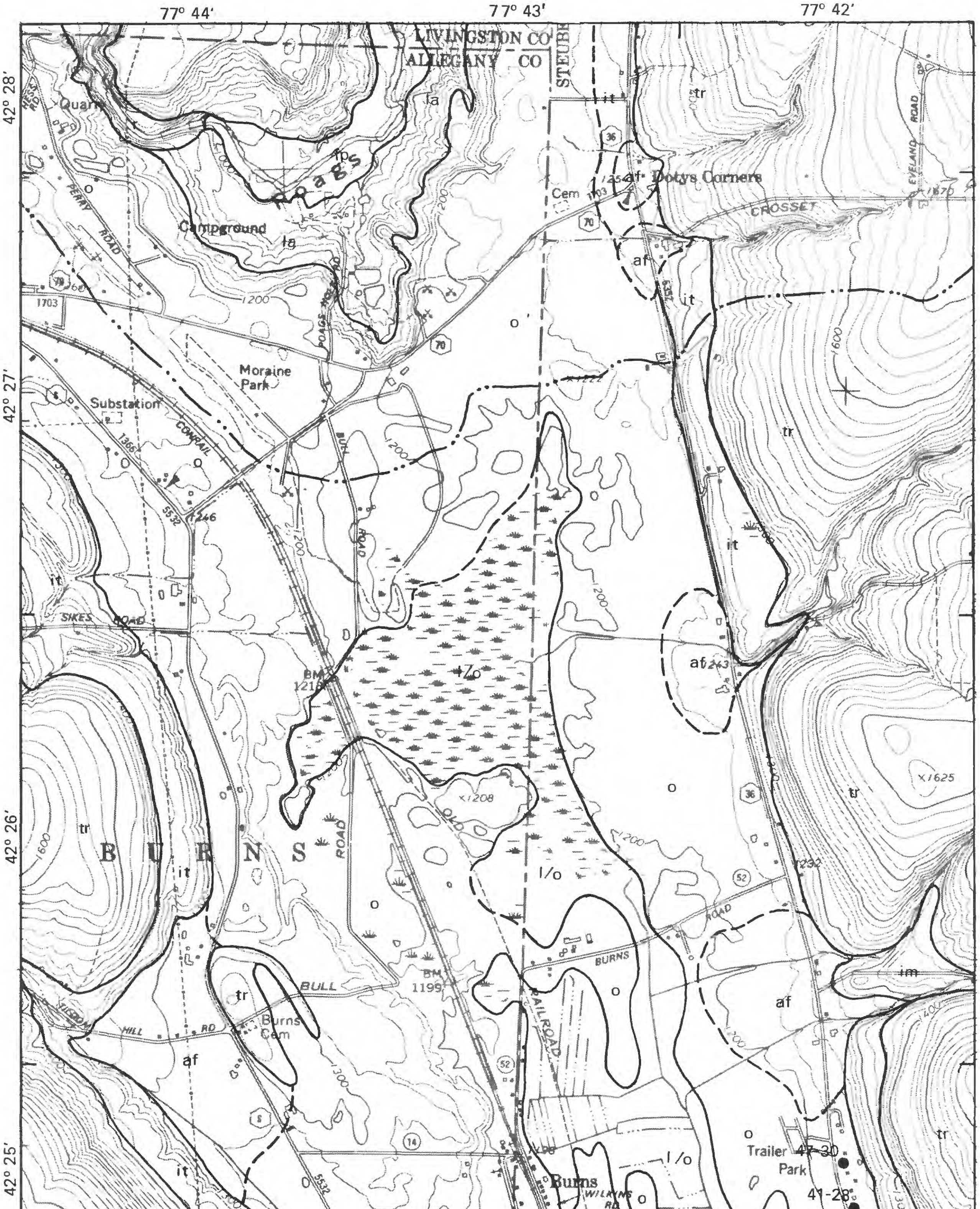
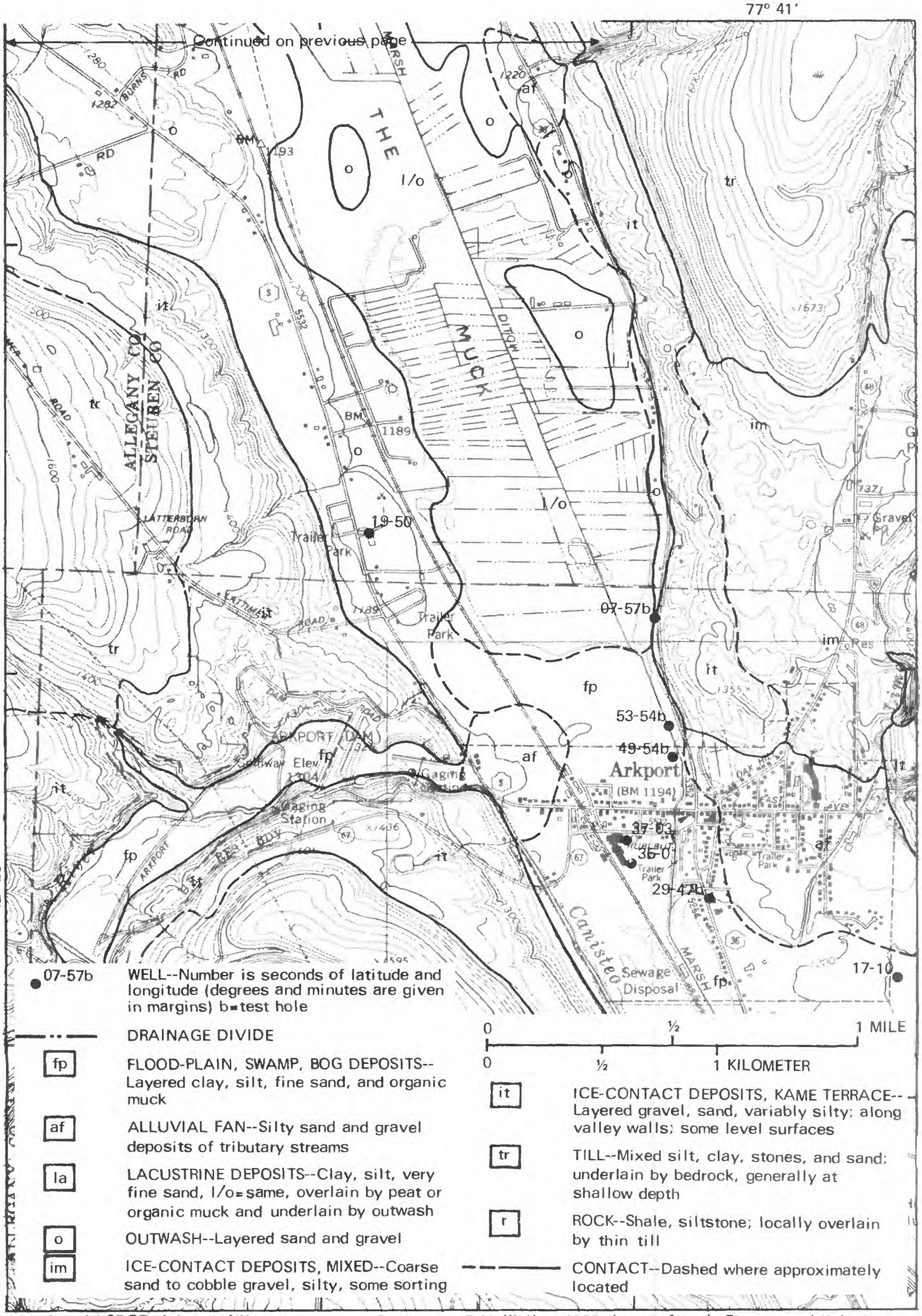


Figure 34.--Reconnaissance map of Burns valley showing surfical geology and well and test-hole locations.



Base from NYSDOT, Arkport, NY, 1977, 1:24,000

Geology by R.M. Waller, 1982, in part from LaFleur, unpublished maps, 1966. Mansue and others (in press), and French and others (1978)

Hydrology.--Recharge to the valley fill results from precipitation on the valley floor and seepage from the numerous tributary streams. Most ground-water discharge probably occurs by evapotranspiration in the wetlands and by discharge to the Marsh Ditch system, which has been in use for nearly 100 years and drains much of the valley floor. The ditch was deepened in the fall of 1973 (U.S. Soil Conservation Service, written commun., 1974), which lowered the water table about 3 feet all across the valley floor (Mr. Schultize, Arkport, N.Y., oral commun., 1982). Nevertheless, the water table is still close to land surface near the valley axis. Ground water also discharges from the valley by springs at the base of the surficial outwash along the bluff above Canaseraga Creek in Poags Hole (fig. 34) and by underflow southward past Arkport.

Saturated thickness of the outwash and flanking kame terraces is probably between 10 and 40 feet (MacNish and Randall, 1982). Greatest saturated thicknesses are probably near the axis of the valley, where most of the outwash lies below organic deposits and below the water table. Lesser saturated thicknesses probably occur near the valley sides, where the base of the outwash may be higher than in midvalley (table 7), and the base of the kame terraces atop bedrock is probably even higher.

Evaluation.--Burns valley is one of the longest and widest through valleys and thus may be able to provide relatively large seasonal yields. Subsurface conditions are poorly known, though, and the saturated thickness of the outwash may be too small to permit rapid and efficient withdrawal of large volumes of water from storage. However, if the lacustrine deposits beneath the outwash include much fine sand as well as silt or overlie permeable gravel along the margins of the kame terraces, properly constructed wells could perhaps obtain large yields from these deeper units. Another consideration is that the large aquifer area in Burns valley is not accompanied by a correspondingly large area of till-covered hillsides or tributary upland basins that drain to or across the aquifer. For example, the ratio of upland area to aquifer area is 2.2 at Harford, described earlier as a quantitative example, but is only 0.8 at Burns. Hence, recharge from upland runoff, when expressed as volume per square mile of aquifer, is probably less in Burns valley than in many other through valleys.

The purpose of the extensive ditch system in Burns valley is to lower the water table far enough to permit cultivation of crops on the muckland. Further lowering of the water table in late summer by seasonal pumping might hinder agriculture by eliminating the subirrigation now available from the shallow water table, whose altitude is regulated by control structures on the ditches. Some private wells penetrate only a few feet below the water table; their yields could be significantly reduced by large seasonal withdrawals.

CONCLUSIONS

At least 29 broad valleys along the northern fringe of the Susquehanna River basin are drained only by tiny headwater streams. Most of these valleys are between 0.8 and 8 square miles in area and are underlain by permeable sand and gravel deposited by glacial meltwater. Geologically they resemble other broad valleys in the Susquehanna River basin except for the widespread presence of till near their northern ends. They are distinctive, however, in that they are not crossed by large streams. Therefore, large ground-water withdrawals from these valleys would not be promptly replenished by induced infiltration of river water that originated elsewhere--a process that would occur in most valleys crossed by large streams and would soon result in depletion of river flow nearly equal to the rate of ground-water withdrawal.

Many of the 29 valleys contain significant ground-water reservoirs with a unique potential for use when streamflow is critically low because such use would not cause large and immediate reduction of streamflow downvalley. Any reduction in streamflow caused by pumping would decrease in magnitude with time during prolonged dry periods. Extrapolating from a single example studied in detail, one might expect many of these valleys to be capable of supplying ground-water withdrawals of roughly 4 $(Mgal/d)/mi^2$ for 2 months each summer without reducing the flow of streams downvalley during the period of pumping by more than 15 percent of the pumping rate. Much longer seasonal withdrawals should be feasible in occasional dry years if more than 1 year were allowed for aquifer replenishment and water-level recovery.

Each valley has its own geometric and cultural characteristics that constrain aquifer use. A few of the 29 valleys abut a major stream at one end, which would enable continuous withdrawals near the stream during most of the year, alternating with seasonal withdrawals remote from the stream, somewhat as proposed by Randall (1977, p. 26). Saturated thickness of surficial sand and gravel is generally less than 30 feet in several valleys, chiefly those in Oneida, Madison, and western Steuben counties, which would probably limit the yields obtainable from conventional well fields. Several valleys contain recreational lakes, wetlands, agricultural land, many domestic wells, or other features whose function would be affected by large seasonal lowering of the water table. In nearly half the valleys, the till-covered uplands that border and drain across sand and gravel on the valley floor are relatively narrow--less than twice the valley-floor area--which might limit perennial seasonal withdrawals because the increased recharge needed to refill the valley aquifers after they were depleted could come only from upland storm runoff.

If intensive seasonal use of the ground-water reservoirs in one or more of these valleys were proposed, detailed studies would be needed to estimate potential seasonal yield accurately. Infiltration of runoff from the uplands was estimated to constitute 60 percent of total recharge to aquifers in Harford valley under natural conditions. Some additional recharge from upland runoff could be expected after periods of seasonal withdrawal because of the lowered water table in surficial gravel aquifers, but this effect has not been measured nor appraised in detail. Rapid water-table rises during brief periods of flow in previously dry channels have been documented in the Harford valley (figs. 7, 8) and elsewhere (Randall, 1978, p. 292-3), but data on the extent to which seepage rates vary with time after initial channel wetting and with head distribution near the channel have not been measured in the Susquehanna River basin.

REFERENCES CITED

Andrews, D. E., and Jordan, Richard, 1978, Late Pleistocene history of south-central Onondaga County, in Merriam, D. F., ed., Guidebook for 50th annual meeting, New York Geological Association.

Austin, M. E., 1953, Soil survey of Tioga County, New York: U.S. Department of Agriculture Soil Conservation Service, series 1939, no. 20.

Bentall, Ray, 1963, Shortcuts and special problems in aquifer tests: U.S. Geological Survey Water-Supply Paper 1545-C, 117 p.

Bielo, R. J., 1979, Special ground water study, Plan of Study: Harrisburg, Susquehanna River Basin Commission, 79 p.

Brigham, A. P., 1897, Glacial flood deposits in Chenango valley: Geological Society of America Bulletin v. 8, p. 17-30.

Buller, William, 1978, Hydrologic appraisal of the water resources of the Homer-Preble valley, New York: U.S. Geological Survey Water-Resources Investigations Open-File Report 78-94, 31 p.

Buller, William, Nichols, W. J., and Harsh, J. F., 1978, Quality and movement of ground water in the Otter Creek-Dry Creek basin, Cortland County, New York: U.S. Geological Survey Water-Resources Investigations Open-File Report 78-3, 63 p.

Coates, D. R., 1966a, Discussion of K. M. Clayton "Glacial erosion in the Finger Lakes region (New York, U.S.A.)": Berlin, Zeitschr. Geomorphologie, neue Folge, Bd. 10, Heft 4, S. 469 [new ser. v. 10, no. 4, p. 469].

Cosner, O. J., and Harsh, J. F., 1978, Digital-model simulation of the glacial-outwash aquifer, Otter Creek-Dry Creek basin, Cortland County, New York: U.S. Geological Survey Water-Resources Investigations Report 78-71, 34 p.

Crain, L. J., 1974, Ground-water resources of the western Oswego River basin, New York: New York State Department of Environmental Conservation Basin Planning Report ORB-5, 137 p.

Denny, C. S., and Lyford, W. H., 1963, Surficial geology and soils of the Elmira-Williamsport region, New York-Pennsylvania: U.S. Geological Survey Professional Paper 379, 60 p.

Ferris, J. G., Knowles, D. B., Brown, R. H., and Stallman, R. W., 1962, Theory of aquifer tests: U.S. Geological Survey Water-Supply Paper 1536-E, 174 p.

French, L. M., and others, 1978, Soil survey of Steuben County, New York: U.S. Department of Agriculture Soil Conservation Service, 120 p.

Hollyday, E. F., 1969, An appraisal of the ground-water resources of the Susquehanna River basin in New York State: U.S. Geological Survey Open-File Report, 52 p.

Hutton, F. Z., and Rice, C. E., 1977, Soil survey of Onondaga County, New York: U.S. Department of Agriculture Soil Conservation Service.

Ku, H. F. H., Randall, A. D., and MacNish, R. D., 1975, Streamflow in the New York part of the Susquehanna River basin: New York State Department of Environmental Conservation Bulletin 71, 130 p.

Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.

MacNish, R. D., and Randall, A. D., 1982, Stratified-drift aquifers in the Susquehanna River basin, New York: New York State Department of Environmental Conservation Bulletin 75, 68 p.

MacNish, R. D., Randall, A. D., and Ku, H. F. H., 1969, Water availability in urban areas of the Susquehanna River basin--a preliminary appraisal: New York State Water Resources Commission Report of Investigation RI-7, 24 p.

Mansue, L. J., Young, R. A., and Miller, T. S., Sources of movement of sediment in the Canaseraga basin near Dansville, New York: U.S. Environmental Protection Agency, in press.

Miller, T. S., Brooks, T. D., Stelz, W. G., and others, 1981, Geohydrology of the valley-fill aquifer in the Cortland-Homer-Preble area, Cortland and Onondaga Counties, New York: U.S. Geological Survey Open-File Report 81-1022, 7 sheets. Summary included in Waller, R. M., and Finch, A. J., 1982, Atlas of eleven selected aquifers in New York: U.S. Geological Survey Water-Resources Investigations Open-File Report 82-553.

Muller, E. H., 1966, Glacial geology and geomorphology between Cortland and Syracuse: Nat. Assoc. Geol. Teachers, Eastern Sect., Field Trip Guidebook, Cortland Area, p. 1-15.

National Weather Service, 1951-80, Climatological data.

Neeley, J. A., 1965, Soil survey of Tompkins County, New York: U.S. Department of Agriculture Soil Conservation Service, series 1961, no. 25.

New York Climate Office, 1979-80, Monthly meterological summary, Cornell research farms: Ithaca, N.Y., Co-operative extension, U.S. Department of Agriculture, Cornell University.

Olmsted, F. H., and Hely, A. G., 1962, Relation between ground water and surface water in Brandywine Creek basin, Pennsylvania: U.S. Geological Survey Professional Paper 417-A, 21 p.

Randall, A. D., 1970, Movement of bacteria from a river to a municipal well--A case history: American Water Works Association Journal, v. 62, no. 11, p. 716-720.

_______, 1972, Records of wells and test borings in the Susquehanna River basin, New York: New York State Department of Environmental Conservation Bulletin 69, 92 p.

_______, 1977, The Clinton Street-Ballpark aquifer in Binghamton and Johnson City, New York: New York State Department of Environmental Conservation Bulletin 73, 87 p.

_______, 1978, Infiltration from tributary streams in the Susquehanna River basin, New York: U.S. Geological Survey Journal of Research, v. 6, no. 3, p. 285-297.

_______, 1981, Hydrology in relation to glacial geology along the Susquehanna River Valley, Binghamton to Owego, New York, in Enos, Paul, ed., Guidebook for field trips in south-central New York: New York State Geological Association, 53d Annual Meeting Guidebook, Binghamton, N.Y., 1981, p. 147-170.

Reynolds, R. J., 1987, Hydrogeology of the surficial outwash aquifer at Cortland, Cortland County, N.Y.: U.S. Geological Survey Water-Resources Investigation Report 85-4090, 43 p.

Reynolds, R. J., and Brown, G. A., 1984, Hydrogeologic appraisal of a stratified-drift aquifer near Smyrna, Chenango County, N.Y.: U.S. Geological Survey Water-Resources Investigations Report 84-4029.

Schneider, W. J., and Ayer, G. R., 1961, Effect of reforestation on streamflow in central New York: U.S. Geological Survey Water-Supply Paper 1602.

Scott, J. H., Tibbets, B. L., and Burdick, R. G., 1972, Computer analysis of seismic refraction data: U.S. Bureau of Mines Report of Investigations 7595, 95 p.

Sery, B. D., 1961, Soil Survey of Cortland County, New York: U.S. Department of Agriculture Soil Conservation Service, series 1957, no. 10.

Susquehanna River Basin Coordinating Committee, 1971, The Susquehanna River Basin Study Report: U.S. Army Engineers, Baltimore, Maryland, 16 volumes.

Trescott, P. C., Pinder, G. F., and Larson, S. P., 1976, Finite-difference model for aquifer simulation in two dimensions with results of numerical experiments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 7, chapter C1, 116 p.

U.S. Geological Survey, 1951-80, Water resources data for New York: Albany, N.Y., U.S. Geological Survey (issued annually).

U.S. Geological Survey, 1979, New York cooperative snow survey: Albany, N.Y., U.S. Geological Survey (issued monthly December through April).

VanAlstyne, Fred, and others, 1982, Ground-water resources evaluation with modeling of flow conditions, Big Flats, N.Y.: Albany, N.Y., New York State Department of Environmental Conservation, 128 p.

von Engeln, O. D., 1961, The Finger Lakes Region, its origin and nature: Ithaca, N.Y., Cornell University Press, 156 p.

Walton, W. C., 1962, Selected analytical methods for well and aquifer evaluation: Illinois State Water Supply Bulletin 49, 81 p.

Table 7.--Records of wells and test holes.

Table 7.--Records of wells and test holes

EXPLANATION OF COLUMN HEADINGS

All columns	A dash indicates no information was obtained.
Site-identification:	The wells, springs, and test borings cited in this report are numbered according to a geographic (latitude-longitude) grid system. The complete number corresponds to the latitude and longitude coordinates of the well. For example, well 432218073172401 is at 43°22'18" north latitude and 73°17'24" west longitude. This locates the well to the nearest second, approximately equal to a 75- x 100-foot rectangle. The maps in this report show degrees and minutes of latitude and longitude in the margins; seconds are given beside the well symbols. The letter "b" after the number means that the record is of a test boring.
Finish:	C, porous concrete; G, gravel with screen; O, open end; P, perforated casing; S, screen; T, sand point; X, open hole; Z, other
Principal aquifer:	110QRNR, Quaternary, undifferentiated; 112TILL, till; 112SRFD, stratified drift; 112ICNC, ice contact material; 112OTSH, outwash; 112SAND, sand; 112SDGV, sand and gravel; 340DVNN, Devonian; 344HMLN, Hamilton group; 344ONDG, Onondaga Limestone; 341SONY, Sonyea Formation; 341JWWF, Java-West Falls Formation; 341DVNNU, Upper Devonian
Aquifer Lithology:	BR, bedrock; CL, clay; CLGL, clay & gravel; CS, coarse; F, fine; G, GL, GRVL, gravel; HP, hardpan (till or very silty gravel); LMSN, limestone; MED, medium; PEB, pebbly; SD, S, sand; SDGL, sand & gravel; SHLE, shale; SI, silt; SNDS, sandstone; VF, very fine; QS, quicksand (very fine sand and silt)
Altitude:	LSD, land surface datum; general surface at well site

Table 7.--Records of wells and test holes (continued).

EXPLANATION OF COLUMN HEADINGS

Water level: Numerals give the water level, in feet below or above (if preceded by +) land surface. Letters give the source of information, as follows:

D, from driller's records
E, estimated
R, reported
S, measured by USGS

If a second letter is present, its meaning is as follows:

F, well overflowing at depth indicated
P, pump operating
R, pump recently operating

Yield:

GPM, gallon per minute
B, bailer
W, weir
E, estimated
V, volumetric
R, reported, method of measurement unknown
O, orifice plate on pump discharge

Well use:

A, air conditioning
C, commercial
F, fire protection
H, domestic
I, irrigation
N, industrial
O, observation
P, public
S, stock
T, test
U, unused
Z, destroyed

Type of log available:

D, by driller from records
Z, other
G, by geologist or soils technician, from records
M, from someone's memory

Condensed logs are given in remarks. Detailed logs for some wells are published (Randall, 1972); others on file at USGS, Albany, N.Y.

Remarks:

ABND, abandoned
DD, drawdown
DISS, dissolved
FE, iron
GPM, gallons per minute
HR, hours
HWY, highway
H2S, sulfur smell
LSD, land surface datum
MEAS, measured
MED, medium
OBS, observation
PL, pumping level
REPT, reported
SWL, static water level
T, TEMP, temperature
TH, test hole
WL, water level

Where log is given, see abbreviations for "Aquifer Lithology" column; measurements are in feet. Hardness is given in mg/L, milligrams per liter or GR, grains per gallon (x 17.1 = mg/L).

Table 7.--Records of wells and test holes

[Locations are shown in the illustrations indicated]

Site identification	Owner	Depth of well (ft)	Finish	Depth cased	Casing diameter (in.)	Principal aquifer	Aquifer lithology
SCHENEVUS CREEK (fig. 18, p. 50)							
423634074410701	NY DEPT TRANSP	295.00	X	178	8	344HMLN	SNDS,FINE, GRAY
423634074410702	NY DEPT TRANSP	215.00	X	180	8	344HMLN	SNDS,FINE, GRAY
423641074411601	DUDLEY, BERNARD	180.00	O	180	6	112SDGV	SAND
423712074400501	UMBACH, ERNEST	77.00	X	40	6	--	SHLE, SILTSTONE
423713074403701	ANTEMAN, W. H.	40.00	O	40	6	--	--
423715074403501	ANTEMAN, W. H.	50.00	O	50	6	--	--
423741074391601	KOHLER	91.00	--	--	6	--	--
423744074391701	VODAPIVC	120.00	--	--	6	--	--
423744074392101	FIEDERER, JOE	65.00	X	42	6	--	--
423744074392501	HAMMERT, RALPH	105.00	X	20	6	--	--
423744074393801	NY DEPT TRANSP	46.50	--	--	3	112GRVL	--
423746074393401	KNAPP, JAMES	100.00	--	--	5	110QRNR	GRVL
423803074383401	FRYE, WILLIAM	96.00	X	66	6	344HMLN	--
423814074392401	ANTEMAN, LARRY	76.00	X	44	6	--	--
423819074392001	COGER, EVELYN	101.00	X	30	--	344HMLN	SHALE
423824074391601	PRESTON, DONALD	90.00	X	25	6	344HMLN	SHALE
423828074391201	MOORE, ROBERT	71.00	--	21	6	344HMLN	SHALE
BRIDGEWATER FLATS (fig. 19, p. 52-53)							
425234075135901	HARRIS, ADA	140.00	X	42	6	--	SHALE
425241075143601	NY DEPT TRANSP	51.50	O	50	3	112OTSH	SDGL,SANDY GRVL,SILTY
425300075150101	TOWN OF BRIDGWATER	20.00	S	--	1.5	--	--
425303075150101	TOWN OF BRIDGWATER	40.40	O	--	5	--	--
425304075150001	SCHALLER, JOHN	37.00	O	37	6	110QRNR	--
425306075155601	SCHALLER, JOHN	47.70	O	48	6	112GRVL	GRVL,SANDY
425308075145901	KENNEDY, WILLIAM	42.00	T	40	2	112SDGV	SDGL,COARSE
425318075145801	WASHBURN, BETTY	13.00	W	0	30	110QRNR	SAND,CLAYEY
425326075150501	CAREY, DAVE	77.00	O	77	6	112GRVL	GRVL
425329075144201	LAUKAITIS, ED	73.00	X	--	--	112SDGV	SDGL
425331075144701	LAUKAITIS, ED	60.00	O	60	6	110QRNR	--
425331075144702	LAUKAITAS, ED	84.00	O	84	6	112GRVL	--
425333075144901	FRISCHKNECT, URSULA	55.40	O	55	6	110QRNR	--
425338075144601	THORP, HARRY	50.00	O	50	4	--	--
425405075143801	COPE, CLARENCE	--	--	--	3.5	112SDGV	SAND,GRAVELLY
425409075143201	VODY, PARA	20.00	O	20	6	110QRNR	--
425416075143401	OERTLE, ULRICH	110.00	O	110	6	110QRNR	--
425421075150901	SOUTHWORTH, KATHLEEN	45.00	O	45	6	--	--
425423075143101	WROBEL, JOE	18.00	--	18	1.75	110QRNR	--
425442075150501	GRANT	12.00	W	0	144	112TILL	SILT,CLAY,BOULDERS
425451075143001	HALLENER, PETER	25.00	O	25	6	110QRNR	--
425501075143701	OERTLE, JOHN	16.00	O	16	6	112OTSH	SAND
425515075144501	LOWELL, LAWRENCE	22.00	O	22	6	--	--
425546075145501	SCAGLIONE, NANCY	37.00	X	6	6	344ONDG	LMSN
425549075145801	HUNGERFORD, BRUCE	150.00	X	20	6	--	--

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				SCHENEVUS CREEK				
167	--	1431.4	31.00 R	01/31/1977	56 R	C	D	DD 7FT, 12HR;HWY REST AREA
152	--	1429.4	27.00 R	02/02/1977	60 R	C	D	DD 2.5FT,12HR;HWY REST AREA
--	--	1435	24.00 R	08/ /1963	45 E	C	--	
--	40	1441	15.00 E	10/ /1964	5 E	H	M	SDGL 0-20, TILL 20-40 FT
--	40	1460	16.00 R	11/ /1979	55 R	C,H	M	SI 0-36, CS SD 36-40 FT
--	--	1455	13.21 S	11/15/1979	25 R	H	--	FLOWS IN SPRING AT 4FT(PIT)
--	--	1520	37.22 R	11/28/1979	--	H	--	
--	--	1540	10.20 R	11/28/1979	--	H	--	
--	--	1505	--	--	16 R	H	--	DUG WELL, WL 0(SPRING)-8 FT
--	--	1490	29.00 R	1967	11 R	H	--	
10	--	1445.6	4.80 D	12/15/1972	--	T	D	SILT 0-10, GRVL 10-46.5 FT
--	--	1460	8.88 S	11/28/1979	--	H	--	
66	--	1480	11.49 S	11/16/1979	--	C,H	--	
--	--	1500	26.80 SR	11/15/1979	10 R	H	--	
30	30	1510	--	--	8 R	H	M	TILL 0-30, BR 30-101 FT
25	--	1520	--	--	--	H	--	IRON STAIN ON FIXTURES
21	--	1540	--	--	4 R		--	WATER REPORTEDLY HARD
				BRIDGEWATER FLATS				
--	--	1232	+1.50 R	08/ /1965	20 E	H	D	SDGL 0-25, TILL 25-42 FT
12	--	1176	0.00 RF	02/27/1978	--	T	D	SI 0-12, F SD-22, SDGL,SI-52
--	--	1210	10.00 E	1958	10	C	M	BLACK SAND 0-20 FT
--	--	1205	2.35 S	11/09/1979	--	T	--	PENETRATES BLACK SAND
--	--	1205	3.28 S	04/22/1975	30 D	C	--	
--	--	1200	+2.50 SF	04/24/1980	93 R	H	--	HARDNESS 20 GR
--	--	1202	20.00 R	1966	10 R	H	--	CS SDGL AT BOTTOM
--	--	1202	4.00 R	07/ /1976	--	H	--	BOULDER AT BOTTOM
--	--	1270	71.54 S	09/02/1980	25 R	H	--	
--	--	1225	18.00 S	09/02/1980	--	T	G	USGS TEST HOLE
--	--	1220	14.00 R	--	5 E	U	--	REPLACED 1973
75	--	1220	30.00 R	--	--	H	M	SD 0-70,CL 70-75,GRVL AT 84
--	--	1220	15.69 S	11/07/1979	--	H	--	SLIGHT SULFUR ODOR
--	--	1220	17.45 S	11/07/1979	5 E	H	M	SD 0-22, CL-38, GRVL-50 FT
--	--	1228	8.20 S	04/23/1980	--	C	--	
--	--	1230	9.65 SR	11/19/1979	--	H	--	
--	--	1230	--	--	--	H,S	M	CL 0-110, SAND? AT 110 FT
--	--	1255	4.37 S	11/29/1979	--	H,S	--	FLOWS IN SPRING AT +2.1 FT
--	--	1232	13.00 R	--	--	H	--	
--	12	1280	3.00 E	06/ /1979	--	H,S	--	
--	--	1240	14.50 S	04/23/1980	7 R	H	--	DRILLED TO 175 FT, HOLE CAVED
--	--	1236	14.43 S	11/30/1979	10 E	H,S	--	BR WELL 300+ DEEP, SALTY,ABND
--	--	1246	6.00 R	01/ /1952	10 E	H	--	
--	5	1280	15.85 S	11/29/1979	40 R	C	--	GRVL 0-5 FT
--	--	1301	30.00 R	04/ /1966	--	H	--	GRVL 0-20 FT

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin-ish	Depth cased	Casing diam-eter (in.)	Principal aquifer	Aquifer lithology
		BRIDGEWATER FLATS (Continued)					
425550075145901	HUNGERFORD, GLADYS	88.00	X	20	6	--	LMSN
425555075144701	GUSTAVSON, KENNETH	57.00	O	57	6	--	--
425557075145201	LOOMIS, MAURICE	31.00	O	31	4	112GRVL	GRVL
425618075151001	HOWARD, WILLIAM	145.00	X	22	6	BEDROCK	LMSN
425637075150501	SCHOLL, VINCE	104.00	O	104	6	112SDGV	GRVL,FINE,SILTY
425644075151601	HOWARD, WILLIAM	120.00	O	120	6	112OTSH	GRVL
		MADISON-BOUCKVILLE (fig. 20, p. 56-57)					
425206075335901	STORES, DANIEL	34.00	O	34	6	112GRVL	GRVL,PEBBLE
425241075332101	MORGAN, EMERSON	37.00	T	35	2	112SRFD	--
425243075332001	MORGAN, EMERSON	30.00	S	--	--	112SDGV	SDGL
425309075335501	WOOD, HARRY	155.00	X	55	6	344HMLN	SHLE
425313075330601	NASSIMOS, JOSEPH	336.00	O	336	6	112HMLN	SHLE
425313075330602	NASSIMOS, JOSEPH	19.00	O	21	6	112SAND	SAND,FINE
425314075333001	SCHOOL, AUTO MECHS	210.00	O	210	6	110QRNR	GRVL
425315075332601	BORATYN, JOHN	60.00	O	60	5	110QRNR	GRVL
425324075330401	HAUCK, ROGER	18.00	T	16	1.25	112GRVL	GRVL,VERY FINE
425327075330201	BARBER, STEWART	22.00	T	20	1.75	110QRNR	SAND
425328075324501	WEINSTEIN	25.00	T	17	2	110QRNR	--
425329075330101	KEMP, GORDON	25.00	O	25	6	110QRNR	--
425336075321301	WILLIAMS, LEE	230.00	O	230	6	112SRFD	SAND,SILTY
425345075325201	BORATYN, JOHN	32.00	O	32	6	112SAND	SAND
425346075325001	BORATYN, JOHN	190.00	O	190	6	112GRVL	GRVL
425411075320801	LIVERMORE, MARCELLA	51.20	O	--	6	110QRNR	--
425411075322801	EDGARTON, ALBERT	290.00	O	290	5	110QRNR	GRVL, FINE
425412075313801	KIEHN, ARTHUR	17.00	T	15	1.75	112SDGV	SDGL,GRAVELLY SAND
425416075322901	LIVERMORE, LEON	32.00	O	32	6	112GRVL	GRVL
425420075321401	LIVERMORE, ROGER	30.00	O	30	6.50	112GRVL	GRVL
		PINEWOODS (fig. 20, p. 56-57)					
425202075351301	VROLYCK, THEODORE	73.00	O	73	6	112SDGV	GRVL,CLAY LENSES
425209075345901	DENNIS, ROY	74.00	O	74	6	110QRNR	--
425235075351201	HOWLETT, HAROLD	50.00	O	50	6	112GRVL	GRVL
425244075342001	MOSHER, JEAN	30.00	O	30	5	112SRFD	--
425246075341901	MOSHER, HOWARD	26.70	W	--	24	110QRNR	--
425255075351201	BIERCE, JOHN	40.00	O	40	6	112SDGV	SDGL
425302075351301	MOSHER, HOWARD	25.00	W	--	36	110QRNR	--
425314075344901	HOWLETT, BOB	103.00	O	103	6	112GRVL	GRVL
425317075351201	KELLY, DENNIS	132.50	O	--	6	110QRNR	--
425318075345401	RESTAURANT, ARIZONA	142.00	O	142	6	110QRNR	SAND
425321075351701	KELLY, DENNIS	114.00	O	114	6	112SRFD	SAND,FINE BLACK
425323075355801	BONO, STEVE	33.50	S	32	1.50	110QRNR	--
425324075354001	BONO, CESARO	26.50	T	25	1.50	112GRVL	GRVL
425336075353601	SALIBA, JERRY	113.00	X	--	--	112SDGV	SDGL,SILTY
425340075361601	RIFENBERG, KEN	112.20	X	12	6	344HMLN	SDMN

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				BRIDGEWATER FLATS (Continued)				
--	--	1302	30.00 R	05/ /1967	6 E	H	M	GRVL 0-20, LMSN 20-88 FT
--	--	1270	27.00 R	05/ /1956	20 E	H	--	GRVL 0-57 FT
--	--	1272	20.00 R	08/ /1966	8 R	H	M	GRVL 0-12, HP, SD, HP, GRVL
22	22	1290	9.00 R	1955	0.5 B	H	D	GRVL 0-22 FT
80	--	1245	49.00 R	01/ /1980	5 R	H	D	GL 0-40, SD 40-80, GL 80-104
--	--	1243	8.00 R	1964	25 B	H	D	HP 0-34, GL HP 34-116, GL-120
				MADISON-BOUCKVILLE				
--	--	1140	22.00 R	08/ /1974	30 B	H	--	GRVL 0-14, PEB GRVL 14-34
--	--	1150	23.50 R	--	100 R	H	--	
5	--	1150	26.00 R	--	--	U	--	
55	55	1190	26.00 S	05/21/1980	0.3 V	S	--	GRVL 0-55;PL 34FT AT 0.3 GPM
336	336	1150	--	--	10 B	U	M	WATER SALTY;CL,QS 40-336
--	--	1150	16.49 S	05/06/1980	--	H	--	GRAVEL BACK FILLED 25-19 FT
200	210	1160	--	--	5 B	T	M	GRVL0-50,CL 50-200,GRVL 200-210
35	--	1158	35.00 R	08/ /1964	--	S	M	GRVL 0-35, F-CS SD 35-60
--	--	1145	11.00 R	09/ /1969	5 V	H	D	CS GRVL 0-6,VF GRVL 6-18
--	--	1153	17.00 R	1955	3 V	H	--	WL CONTROLLED BY CANAL
--	--	1160	18.00 R	1978	10 E	H	--	
--	--	1150	17.00 R	1970	--	H	--	WATER VERY HARD
--	230	1180	45.00 D	1970	30 R	H	D	GRVL,SD 0-35;SD,SI,CL 35-230
--	--	1162	25.00 R	1973	10 B	H	--	GRVL OVER SD; HIGH IRON
--	--	1162	--	--	6 B	U	--	ABANDONED, MINERALIZED WATER
--	--	1170	40.18 S	05/01/1980	--	H	--	
285	--	1160	54.00 R	--	20	--	D	SDGL 0-20,FS 20-285,G 285-290
--	--	1160	7.00 R	1964	10 R	H	--	GRVL SAND 0-17
--	--	1150	27.00 R	1970	20 B	H	--	WL CONTROLLED BY CANAL
--	--	1150	12.00 R	11/ /1979	50 R	H	--	IRON STAIN IN SINK
				PINEWOODS				
--	--	1205	40.00 D	1952	40 B	H	--	
--	--	1180	37.16 S	05/20/1980	40 B	P	--	WATER HARD,IRON; TRAILER PARK
40	--	1180	39.29 S	05/21/1980	20 B	H	D	SD 0-12,HP 12-40,G 40-48.5
--	--	1162	20.00 R	--	--	H	--	REDEVELOPED IN 1962
--	--	1162	22.70 S	05/21/1980	--	H	--	DRY IF LELAND POND DRAINED
12	--	1160	23.94 S	05/21/1980	30 R	H	M	G 0-6,CL 6-12,SDGL 12-40,QS?40
--	--	1160	22.00 R	--	--	H	--	
80	--	1141	--	--	20 R	H	D	
--	--	1142	14.63 S	05/21/1980	--	U	--	
109	--	1145	14.00 R	--	200 E	C	M	
--	--	1145	22.77 SR	05/21/1980	--	P	--	TRAILER PARK
--	--	1155	30.50 R	10/ /1976	10 E	H	--	
--	--	1150	22.00 R	--	10 V	H	--	
--	--	1175	6.00 E	10/23/1980	--	Z	G	USGS TEST HOLE
--	--	1190	16.60 S	05/08/1980	--	H	--	

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin-ish	Depth cased	Casing diam-eter (in.)	Principal aquifer	Aquifer lithology
			PINEWOODS (Continued)				
425347075352901	REED, JOHN J	29.00	O	29	6	110QRNR	GRVL
425347075352902	SALIBA, JERRY	20.90	O	21	6	112GRVL	GRVL
425347075352903	SALIBA, JERRY	320.00	O	320	6	112SAND	SAND,VERY FINE, SILTY
425404075361701	REED, JR., JOHN	28.00	O	28	6	112GRVL	GRVL
425410075351501	BRINK, GARTH	61.00	X	--	--	112SDGV	SDGL,PEBBLY,SANDY
425410075355501	HATCH, THOMAS	14.00	T	12	2.50	110QRNR	--
425411075360001	HATCH, THOMAS	42.00	O	42	8	112GRVL	GRVL
425426075361501	REED, GERTRUDE	105.00	O	105	6	112GRVL	GRVL
425429075361401	REED, MARK	90.00	O	98	6	112SRFD	--
425429075361801	POWERS, ROGER	33.70	W	--	24	110QRNR	--
425440075345501	NOURSE, LEON	252.00	X	150	6	340DVNN	SHLE
			SHEDS (fig. 21, p. 60)				
424823075502001	MORSE, WILLIAM	73.00	O	73	6	110QRNR	--
424832075500401	OSSONT, ROBERT	20.20	T	18	1.25	110QRNR	--
424835075500501	OSSONT, ROBERT	58.60	O	--	6	112SAND	SAND,FINE
424836075500301	LEETE, GERALD	165.00	O	165	6	112SAND	SAND,COARSE BLACK
424840075495501	WATERSTRIPE, JAMES	90.00	O	--	6	110QRNR	--
424841075494301	PRESTON, WENDELL	87.00	O	87	6	110QRNR	--
424841075495201	LYNAGH, ANTJE	22.25	W	--	24	110QRNR	--
424842075494701	ROBINSON, WILFRED	85.00	O	85	6	110QRNR	--
424846075494501	JUDSON, JOHN	92.00	O	92	6	110QRNR	--
424848075495201	DARMENTO, ANTHONY	73.00	O	73	6	112SDGV	SDGL
424852075493301	BECKER, FRANCIS	212.00	O?	212?	6	110QRNR?	--
424925075502601	GARNER, CLEON	66.00	X	--	--	112SAND	SAND,SILTY CLAYEY
424938075500501	GARNER, CLEON	22.00	T	20	1.25	110QRNR	--
425009075501101	SHUMACHER	286.00	O	--	--	112GRVL	GRVL
			FABIUS (fig. 24, p. 66-7)				
424931075571601	SWEETLAND, ALBERT	88.00	X	--	--	112SDGV	SDGL,SANDY GRAVEL
424933075570101	VAN SANT, HOWARD	12.00	W	--	24	110QRNR	--
425001075585601	KOSSOF,ALLAN,&SON	170.00	X-	--	.6	--	BEDROCK?
425001075592001	WALSH, TOM	18.00	W	--	24	112SDGV	GRVL
425002075573801	LAMBERT, BRUCE	55.00	--	--	6	112SDGV	GRVL, SANDY
425005075585601	BRIAN, ARTHUR	48.00	O	48	6	110QRNR	SDGL
425007075583001	LEONARD, CHARLES	130.00	O	130	6	112SAND	SAND
425007075584701	DEHART, BILL	80.00	O	80	6	110QRNR	GRVL --
425007075585001	GOFF, DUANE	34.00	O	34	6	112SDGV	GRVL
425009075574201	LAMBERT, HINKLE	17.00	P	--	1.25	110QRNR	--
425009075585301	HAYNES, PHILLIP	74.00	O	74	6	110QRNR	--
425010075581901	LEACH, DAVID	15.00	P	--	1.25	110QRNR	--
425010075582401	BERNARD, MICHAEL	48.00	O	48	6	110QRNR	GRVL
425010075590101	FLETCHER, DON	175.00	--	--	--	--	--
425010075590601	CAMERON, KATHLEEN	70.00	O	70	6	110QRNR	--

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				PINEWOODS (Continued)				
10	--	1165	11.00 R	--	5 B	S	M	
--	--	1162	11.42 S	05/08/1980	10 B	U	--	
105	--	1162	28.96 S	05/08/1980	--	U	M	VERY LOW YIELD
--	--	1178	22.00 R	1960	6 B	S,H	--	HARDNESS 205 MG/L
--	--	1180	8.00 E	10/23/1980	--	Z	G	USGS TEST HOLE
--	--	1160	--	--	5 E	H	--	
20	--	1155	7.00 R	--	30 R	H	M	CL SD 0-20, GRVL 20-40
105	--	1168	15.00 R	1978	--	H	M	GRVL 0-10, QS 30-105
--	--	1168	--	--	--	H	--	REPORTED LOW YIELD
--	--	1168	27.40 S	05/08/1980	5 E	H	--	DRY 10/79 TEMPORARILY
--	--	1200	50.00 R	1957	19 R	H	--	HARD H2S WATER
				SHEDS				
--	--	1400	9.92 S	06/04/1980	--	H	--	HARD; FORMER WELL 96 FT,CAVED
--	--	1415	13.58 S	06/05/1980	--	H	--	NEVER DRY; WL 2 FT IN SPRING
--	--	1425	29.10 S	06/05/1980	3 R	H	--	GL PACK; ORIGINAL 7 GPM; HARD
--	--	1425	35.40 SR	06/05/1980	30 R	H	--	FINES 170?-180 FT, PULLED BACK
--	--	1435	37.36 S	06/04/1980	5 R	H	--	WATER SLIGHTLY HARD
--	--	1440	27.00 R	1947	18 R	H,S	--	FLOWS IN SPRING
--	--	1440	20.16 S	06/04/1980	--	U	--	
--	--	1440	17.00 R	1955	4 R	H	--	
--	--	1440	30.00 R	1947	1 R	H	--	WATER MEDIUM HARD
67	--	1440	30.72 SR	06/04/1980	6 B	H	D	HP 1-67, GRVL 67-73 FT
--	--	1460	58.39 R	06/06/1980	--	H,S	--	WATER SULFURY, SOFT
--	--	1390	14.00 E	10/22/1980	--	Z	G	USGS TEST HOLE
--	--	1435	20.00 R	--	3 R	H,S	--	VERY HARD WATER
--	--	1330	3.50 RF	continuous	4 R	H	M	CL 0-200+, GRVL AT 286 FT
				FABIUS				
--	--	1238	5.00 E	09/16/1980	--	Z	G	USGS TH; GL 0-59 FSD,SI 59-88
--	--	1255	--	--	--	H	--	NEVER GOES DRY
--	--	1278	34.04 S	03/07/1981	3 R	H	--	H2S, METHANE
4	--	1258	16.50 R	--	--	H	--	GRVL 0-18
--	--	1255	20.00 R	--	8 R	H	--	FIRST WATER 15 FT
--	--	1281	20.00 R	01/12/1962	15 R	H	D	GL 0-27, HP 27-47, SDGL 48 FT
--	--	1300	37.50 S	07/08/1980	--	S,H	--	WATER MEDIUM HARD
--	--	1290	23.00 R	--	20 B	H	--	20 GR HARD; WATER, QS AT 50
30	--	1290	16.00 R	1975	15 B	H	M	GL 0-6, 30-34; HP 6-30, 34-36
--	--	1260	--	--	--	H	--	WATER VERY HARD
--	--	1290	--	--	20 R	H	--	WATER HARD, IRON, H2S
--	--	1280	8.00 R	--	--	H	--	HIGH WATER IN SPRING
--	--	1295	14.60 S	06/19/1980	9 R	H	--	BITTER,IRON; 18?FT POINT ALSO
--	--	1287	20.00 R	--	10 R	H	--	H2S, METHANE; 15 FT DUG ALSO
--	--	1278	--	--	5 R	H	--	GRVL 0-6; ODOR

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin- ish	Depth cased	Casing diam- eter (in.)	Principal aquifer	Aquifer lithology
			FABIUS (Continued)				
425010075590801	PILCHER, DAVID	200.00	--	--	6	--	--
425011075591501	HURLIHEY, RICHARD	45.00	O	45	6	110QRNR	--
425014075585701	EATON, LINDA	179.00	O	179	6	112SDGV	GRVL
425018075571501	SWEETLAND, DALE	21.00	O	21	6	112SDGV	GRVL,CS SAND,COBBLES
425020075571301	SWEETLAND, DALE	22.00	O	22	6	110QRNR	--
425020075582401	TOWN OF FABIUS	15.00	T	--	1.25	110QRNR	--
425024075573701	WHEELER, PHIL	15.00	T	--	1.25	110QRNR	--
425036075550501	INGERSOLL, BERNAL	220.00	X	190	6	340DVNN	SHLE
425037075573601	SCHEFTIC, PAUL	50.00	--	--	6	--	--
425039075575601	SCHEFTIC, PAUL	88.00	X	--	--	112SDGV	GRVL,COARSE TO FINE
425041075552901	ENGST, ORVIL	200.00	X	45	6	340DVNN	SHLE
425041075553501	ENGST, ORVIL	79.30	--	--	6	--	--
425044075552301	ENGST, ORVIL	180.00	X	--	6	340DVNN	SHLE
425044075594201	KNAPP, DON & TED	40.00	O	40	6	110QRNR	--
425043075553301	CONWAY, JAMES	125.00	X	60	6	340DVNN	SHLE
425045075582601	KINSLOW, GARRETT	45.00	O	45	5	110QRNR	--
425048075550801	PITTS, BOB	125.00	X	40	6	340DVNN	SHLE
425051075550901	INGERSOLL, BEN	60.00	O	60	6	112SDGV	GRVL
4250520755615	US GEOL SURVEY	23.5	S	20	2	--	SDGL
4250550755546	US GEOL SURVEY	42.50	S	27	2	--	SDGL
4250550755603	US GEOL SURVEY	24.0	S	19	2	--	GRVL
425058075550901	ZIRBEL, JAMES	168.00	O	168	6	110QRNR	--
425100075572601	MANN, ROBERT	20.00	T	--	1.25	110QRNR	--
425106075562301	ENGST, CHIP	23.00	O	23	6	112SDGV	GRVL
425110075562201	ENGST, ORVIL	101.00	X	14	6	340DVNN	SHLE
425113075553401	DWYER, DANIEL	80.00	O	80	6	110QRNR	GRVL, PEBBLE
425117075590201	OLCOTT, CARL	39.00	X	29	--	--	BEDROCK
425123075551101	CLANCY, PATRICK	243.00	O	243	6	110QRNR	--
425142075550701	SKINNER, KENNETH	315.00	X	290	6	340DVNN	SHLE
425231075563701	HEFFERNAN, EDWARD	20.00	W	--	36	--	TILL
			LABRADOR POND (fig. 25, p. 69)				
424505076015101	KEITH, ELDON	42.00	O	42	3	112GRVL	GRVL
424552076012501	LYONS	68.00	X	20E	6	BEDROCK	--
424605076010001	US GEOL SURVEY	6.00	O	8.0?	18	110QRNR	TILL
424641076030601	HOLMAN, BRUCE	75.00	O	75	6	110QRNR	--
424732076031101	NY DEPT ENVIR CONS	154.00	--	154?	6	112SAND	SAND,FINE BLACK
			PREBLE DRY VALLEY (fig. 26B, p. 73)				
424412076091401	MORRIS, LENFORD	53.00	X	50	6	BEDROCK	--
424414076093201	STONE, ROBERT	45.00	O	45	6	110QRNR	--
424416076094701	CORTLAND COUNTY	30.00	S	27	1.75	112OTSH	GRVL
424418076100301	GRISWOLD, HUBERT	42.00	O	42	6	110QRNR	--

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				FABIUS (Continued)				
--	--	1278	24.01 S	04/13/1981	--	H	--	
--	--	1276	18.00 R	07/ /1976	4 R	H	--	LITTLE DD AT 4 GPM
--	--	1298	18.80 SR	04/13/1981	7 R	H	--	MUDDY IN SUMMER; CL, THEN GL
0	--	1255	6.40 S	06/11/1980	--	H	--	SDGL 0-20; WATER HARD, IRON
0	--	1255	6.00 R	08/ /1975	26 R	S	--	GRVL 0-22
--	--	1275	5.00 R	1977	--	C	--	GRVL 0-7
--	--	1262	10.00 R	--	4 R	H	--	WATER VERY HARD
--	190	1320	+1.00 R	1940	5 R	H	--	H2S; CHLORIDE 45 MG/L 9/1961
--	--	1265	15.00 R	--	8 R	H	--	
--	--	1275	23.00 E	10/21/1980	--	Z	G	USGS TH; GL 0-65, TILL 74-88
44	44	1330	43.00 R	05/ /1980	2 B	S	--	DD>150;GL 8-44,CEMENTED 21-44
--	--	1320	26.04 S	06/12/1980	--	H	--	
20	--	1305	50.06 SR	06/12/1980	--	S,H	--	VERY LOW YIELD
--	--	1275	12.00 R	--	--	S	--	GL 0-40; 5 16FT POINTS NEARBY
--	60	1300	20.00 R	1959	2 R	H	--	IRON, H2S; CHLORIDE 28 MG/L
--	--	1305	--	--	--	S,H	--	GOOD YIELD; WATER HARD
--	--	1287	15.00 E	1980	14 B	H	--	WATER HARD, IRON
20	--	1282	20.00 R	1962	48 B	H	M	CL 3-20, GL 20-60, FGL,SD 60
--	--	1270	7.95 S	05/01/1981	--	O	G	TILL, SI GL 0-10, GL 10-27 FT
--	--	1275	14.23 S	05/01/1981	--	O,Z	G	SDGL, SI 0-35, TILL 35-42 FT
--	--	1270	7.60 S	05/01/1981	--	O,Z	G	TILL, SI GL 0-10, GL 10-32 FT
--	--	1280	30.00 R	--	5 B	H	--	WATER HARD, IRON; GL/CL/GL
--	--	1282	--	--	--	H	--	VERY HARD WATER
--	--	1292	4.00 R	03/21/1980	30 R	H	--	GRVL 0-23 FT
13	--	1315	20.00 R	04/03/1980	20 R	H	--	GRVL 0-13, SHLE 13-101 FT
--	--	1280	20.00 R	1979	8 R	S	--	HARD WATER
--	--	1464	26.00 R	10/04/1955	20 R	--	--	
--	--	1260	+4.00 RF	1963	--	H	--	HIGH IRON; F SD, WATER AT 100
--	290	1220	150.00 R	1956	2 R	H	--	IRON; LAYERS SD, CL OVER ROCK
--	--	1540	3.60 S	09/01/1961	--	U	--	
				LABRADOR POND				
41	--	1210	21.00 R	1959	10 R	H	--	WATER HARD; SMALL YIELD AT 20
--	--	1300	7.10 S	07/02/1980	3 R	H	--	HARD WATER
--	--	1370	0.00 S	04/ /1951	--	O	--	WL MEAS 1933-53
--	--	1218	25.00 R	1963	--	H	--	
20	--	1220	+0.25 SF	09/23/1982	25 R	U	M	GL 0-30, F SD 30-154, GL? 154
				PREBLE DRY VALLEY				
44	44	1240	24.00 D	09/24/1963	12 B	H	D	GRVL 0-22, GL+HP 22-44 FT
--	--	1240	23.23 S	07/03/1980	8 R	H	--	
10	--	1221.7	2.57 S	03/31/1977	--	O	--	OBS WELL CT30
			15.53 S	08/25/1977				
--	--	1238	--	--	10 R	S	--	HARD WATER

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin-ish	Depth cased	Casing diam-eter (in.)	Principal aquifer	Aquifer lithology
			PREBLE DRY VALLEY (continued)				
424419076095901	VANPATTEN, THEODORE	26.30	O	26	6	110QRNR	SAND
424447076102501	GRISWOLD, EVERETT	66.00	O	66	6	112SDGV	GRVL
424500076100901	STONE, ROY	135.00	O	135	6	112SDGV	GRVL
424514076101501	VOSSLER, ROBERT	82.00	O	82	6	112SDGV	GRVL
424523076105801	VOSSLER, ROBERT	18.00	W	0	24	110QRNR	SAND
424525076105401	MASTERS, RALPH	34.00	X	--	--	--	--
424558076102601	VANPATTEN, WM	319.00	X	118	6	110QRNR	GRVL & BEDROCK
424623076103301	VANPATTEN,LEE &JOHN	327.00	X	225	6	340DVNN	SHLE
4246060761049	WILLIAMS, PAUL	365.00	X	220	6	BEDROCK	
			HARFORD (fig. 6A, p. 16)				
422518076120501	PROPANE, SUBURBAN	3218.00	X	--	7	--	--
422526076135301	JEWETT, GEORGE	204.00	O	204	6	112SAND	SAND, COARSE
422528076135301	NY COLLEGE AGR(#231)	10.80	O	11	8	--	GRVL, SILTY
422531076134001	DOSS, G. JAMES	220.00	O	220	6	--	NONE
422531076134002	DOSS, G. JAMES	41.00	O	41	6	--	--
422533076133801	HARFORD METHODIST CH	30.40	--	--	6	--	--
422534076133901	TENNANT, DON	32.00	T	--	--	110QRNR	SAND
422534076133902	TENNANT, DON	22.40	W	0	36	--	--
422535076123301	DOSCHER, CARL	58.00	--	--	--	--	--
422548076132801	ADAMS, HOWARD	--	T	--	1.25	--	--
422548076142401	CARPENTER, LYNN	36.00	O	36	5	--	GRVL, FINE
422549076134401	NY COLLEGE AGR (#98)	48.10	S	41	2	112SDGV	GRVL, F TO CS SAND
422549076134402	NY COLLEGE AGR (#97)	22.70	S	18	2	112SAND	SAND, MED TO COARSE
422550076132301	CHEVALIER	80.00	X	--	5	--	BEDROCK
422550076134401	NY COLLEGE AGR (#96)	7.00	S	--	2	--	--
422551076142701	NY COLLEGE AGR	56.00	S	52	2	--	GRVL, SILTY
422555076131601	GOODMORE, IONE	70.00	X	35	6	--	BEDROCK
422556076134001	NY COLLEGE AGR (#99)	37.00	S	22	2	341DVNNU	SHLE,AND/OR SILTSTONE
422557076140801	NY COLLEGE AGR (#93)	10.50	O	11	8	112SDGV	GRVL
422559076144701	LIDDINGTON, RAY	200.00	O	200	4	110QRNR	SAND, SILTY
422600076141101	NY COLLEGE AGR (#90)	49.00	S	39	2	112SDGV	GRVL, CS SAND, SILT
422617076145002	NY COLLEGE AGR	79.70	S	60	12	--	GRVL, SAND
422618076145101	NY COLLEGE AGR(#236)	64.50	S	--	2	112SAND	SAND
422619076145202	NY COLLEGE AGR	78.60	S	59	12	--	GRVL, SAND
422623076141101	NY COLLEGE AGR	152.00	X	50	6	--	BEDROCK
422627076143101	NY COLLEGE AGR (#88)	51.00	S	41	1.50	112SDGV	GRVL, CS SAND
422627076144501	NY COLLEGE AGR	42.40	W	0	--	--	--
422627076144502	NY COLLEGE AGR	50.40	--	--	5	--	--
422631076150001	NY COLLEGE AGR (#75)	37.50	S	35	2	112SDGV	GRVL, SD
422631076150002	NY COLLEGE AGR (#74)	20.30	S	17	1.25	112SDGV	GRVL, SD, SOME SILT
422635076142401	SEAMEN, KENNETH	127.00	X	15	6	BEDROCK	--
422635076143801	NY COLLEGE AGR (#84)	5.9	O	6	8	--	GRVL, SILTY
422636076151001	NY COLLEGE AGR	41.00	T	37	1.25	112SDGV	GRVL, SD, SOME SILT
422636076151002	NY COLLEGE AGR	11.00	S	11	2	112SDGV	GRVL, SD, SOME SILT
422640076144301	NY COLLEGE AGR (#73)	51.40	S	49	2	112SDGV	GRVL,WITH COARSE SAND

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				PREBLE DRY VALLEY (continued)				
22	--	1230	22.00 S	11/03/1966	--	S	--	
--	--	1340	20.00 R	1978	7 R	S,H	--	VERY HARD WATER
--	135	1285	58.43 SR	07/02/1980	7 V	S,H	--	BLACK SHLE AT BOTTOM
--	--	1300	45.89 S	07/03/1980	10 R	S	--	SULFUR WATER
--	--	1260	14.04 S	11/03/1966	--	U	--	
--	--	1270	--	--	--	Z	G	USGS TEST HOLE
--	118	1330	77.82 S	11/03/1966	12 R	U	--	SALT WATER 440 FT, PLUGGED
--	225	1340	30.00 R	07/ /1957	36 R	H	--	SDGL, CLAY, THEN QS OVER SHLE
--	--	1310	145.00 R	08/ /1970	--	S	--	
				HARFORD				
--	110	1176.0	--	--	--	U	G	THICK QS?; GRVL, WATER AT 80?
200	--	1231.9	46.77 S	08/07/1980	15 R	H	D	SDGL EXCEPT CLGL, QS 80-180
6.5	--	1229.9	6.59 S	04/18/1980	--	U	G	DRY WHEN CREEK IS DRY NEARBY
--	--	1212	--	--	0	U	--	MUCH SI,FSD;30 GPM MUDDY 132FT
--	--	1212	31.06 S	04/03/1974	5.0	H	--	--
--	--	1198.1	15.70 S	05/09/1979	--	H	--	FORMER PARSONAGE; HARD WATER
--	--	1200	--	--	--	C	--	HARD WATER
--	--	1201.9	15.13 S	05/07/1979	--	U	--	--
--	--	1206.0	29.58 S	10/22/1980	--	H	--	--
--	--	1196.0	14.67 S	10/17/1980	--	S	--	MOST NEARBY WELLS 20± FT DEEP
--	--	1225	23.00 R	1966	10 R	H	--	CLAYEY GRAVEL REPT IN CELLAR
0	--	1191.5	6.49 S	11/13/1978	--	O	G	SCREEN, SAND PACK 41-51 FT
0	--	1191.2	5.86 S	10/22/1980	--	O	G	--
--	40	1212	--	--	--	H	--	--
--	--	1191.7	1.47 S	04/18/1980	--	O	--	BESIDE 8-IN WELL 7.4 FT DEEP
--	--	1223.9	31.32 S	10/22/1980	--	O	G	SMALL YIELD, VERY SILTY GRVL
--	--	1245	--	--	--	H	--	LARGE YIELD REPORTED
12	13	1197.4	10.27 S	11/15/1978	--	O	G	SCREEN, SAND PACK IN BEDROCK
0	--	1199.8	10.32 S	10/22/1980	--	O	--	WL RECORDER 1979-81; GL 0-11
--	--	1245	35.00 R	1962	28	H	--	NO WATER 0-145 FT
--	--	1213.3	22.90 R	11/21/1978	--	U	G	CASING BROKEN, PLUGGED
28	--	1213	3.70 R	03/24/1971	414 R	F,S	D	PUMPTEST 1971, RECORD ON FILE
30	--	1216.0	10.75 S	04/11/1983	--	O	D	SIMILAR WELLS 100,200 FT N
30	--	1214	7.79 R	04/28/1971	422 R	F,S	D	PUMPTEST 1971, RECORD ON FILE
--	--	1255	19.65 S	03/26/1974	--	H	--	YIELD EXCEEDS 6 GPM
36	--	1238.4	32.20 S	11/16/1978	--	O	G	TILL 8-12, SILTY GRVL 12-36 FT
--	--	1233.5	22.98 S	04/06/1974	--	U	--	WL 39.97 FT 12/11/73
--	--	1233.5	22.88 S	04/06/1974	--	U	--	INSIDE DUG WELL;WL39.85 12/73
28	--	1224.0	12.64 S	04/06/1974	--	O	G	GVL EXCEPT TILL 8-15,18-28 ft
15	--	1224.0	11.03 S	04/06/1974	--	O	G	2ND OF 2 WELLS IN 6-IN HOLE
0	0	1370	15.00 R	06/ /1957	50 R	H	--	CELLAR EXCAVATED IN BEDROCK
--	--	1240.2	1.28 S	04/17/1980	--	O	D	TILL 5-6;NEAR DITCH LSD-2.3FT
18	--	1215.6	21.18 S	10/22/1980	--	O	G	GRVL EXCEPT TILL,SI 2-8,11-18
8	--	1215.6	4.12 S	10/22/1980	--	O	G	BESIDE PRECEDING WELL
47	--	1244.8	48.78 S	10/15/1980	--	O	G	TILL,CL 3-20;SI28-37;TILL? 43
			31.49 S	04/17/1980				

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin- ish	Depth cased	Casing diam- eter (in.)	Principal aquifer	Aquifer lithology
			HARFORD (Continued)				
422640076144302	NY COLLEGE AGR (#72)	41.80	S	40	1.25	112SDGV	SD, CS, PEBBLY
422641076150501	NY COLLEGE AGR	64.00	S	60	2	112SDGV	GRVL, VERY SILTY
422641076150502	NY COLLEGE AGR	26.00	T	24.5	1.25	112SDGV	GRVL, SILTY
422643076142701	NORTE, HARVEY	23.70	O	24	5	--	--
422647076144301	NY COLLEGE AGR	7.$\pm$	W	0	--	--	--
422647076144302	NY COLLEGE AGR	61.80	O	65	6	112SDGV	--
422647076150401	NY COLLEGE AGR (#71)	7.90	O	8	24	112SDGV	--
422648076145101	NY COLLEGE AGR (#70)	9.10	O	9	24	112SDGV	GRVL, SILTY
422649076143301	BAIRD, CHARLES	85.00	X	14	6	--	BEDROCK
422650076143401	KETTER, WILLIAM	76.00	X	17	6	--	BEDROCK
422650076145801	OVERBAUGH, JENNIE	63.50	O	64	6	112SDGV	--
422651076150501	HEIDT, RICHARD	52.50	O	54	6	112SDGV	--
422651076151001	AUSTIN, IRENE	38.40	O	--	6	112SDGV	--
422655076150401	NY COLLEGE AGR(#235)	40.10	S	37	2	112SDGV	SAND, F TO CS
422655076150402	NY COLLEGE AGR	11.60	S	9	1.25	112SDGV	GRVL, SANDY, SILTY
			CAROLINE (fig. 27, p. 75)				
422238076182601	SCAGLIONE, ANTHONY	70.00	O	70	6	112GRVL	GRVL,WHITE ROUND
422245076180501	ROHRER, RICHARD	83.00	O	83	6	112GRVL	GRVL
422246076182601	KOBASA, PAUL	90.00	O	90	6	110QRNR	--
422250076180501	WILLSEY, MARY	75.00	O	75	6	110QRNR	--
422253076183501	WATSON, ALVAH	8.00	--	8	8	110QRNR	--
422254076183601	WATSON, ALVAH	45.00	O	45	6	110QRNR	--
422259076180201	MIX, BILL	68.00	X	--	--	112GRVL	GRVL,SILTY SANDY
422304076185901	KIGER, GEORGE	38.00	O	38	5	112GRVL	GRVL
422330076182001	BARNHART, CHARLES	59.00	X	29	6	341SONY	--
422333076190301	SCRIBER, JEAN	30.00	O	30	6	110QRNR	--
422335076180501	DAVIS, ROWLAND	35.00	O	35	6	110QRNR	--
422335076180601	ROEBEL, JAKE, III	35.00	O	35	6	110QRNR	--
422335076185501	LASHER, CHARLES	98.00	X	33	6	341SONY	--
422335076190101	WEBER, WALTER	32.00	--	--	1.25	112GRVL	GRVL
422336076180301	HILLBERRY, HOWARD	60.00	X	--	6	341SONY	BEDROCK?
422339076191201	CRISPELL, EUGENE	45.00	O	45	6	110QRNR	--
			WILLSEYVILLE CREEK (fig. 28, p. 77)				
421737076224501	ANDREWS, GLEN	115.00	O	115	5	112ICNC	GRVL
421815076233401	DODGE, LARRY	72.00	--	--	6	--	BEDROCK
421837076222801	GUGGENHEIN, RALPH	110.00	X	85?	6	341SONY	--
421839076222701	GUGGENHEIN, RALPH	120.00	X	80?	6	341SONY	--
421853076222601	ELLIS, FRANCIS	83.00	O	83	5	110QRNR	--
421903076222901	BALL, CARL	30.00	O	30	6	110QRNR	--
421905076222701	PARKER, DICK	30.00	O	30	6	110QRNR	--
422030076233101	LAWRENCE, DAVE	77.00	X	--	--	112GRVL	GRVL,PEBBLE,SILTY
422031076230301	FANTON	250.00	X	15	6	341SONY	SHLE
422109076240901	WILCOX, JOHN	73.00	X	--	--	112SDGV	SDGL, SILTY

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				HARFORD (Continued)				
--	--	1244.8	31.57 S	04/17/1980	--	O	G	2ND OF 2 WELLS IN 6-IN HOLE
53	--	1228.5	29.65 S	10/22/1980	--	O	G	
20	--	1224.66	19.39 S	10/22/1980	--	O	G	BESIDE PRECEDING WELL
--	--	1270	8.01 SR	03/27/1974	--	H	--	SILTY GRVL 0-14 FT NEARBY
--	--	1251.0	5.95 S	04/06/1974	--	U	--	DRY EXCPT BRIEFLY EACH SPRING
--	--	1251.0	33.04 S	04/06/1974	--	H	--	INSIDE DUG WELL
--	--	1217.1	3.80 S	04/23/1974	--	O	--	WL RECORDER 1974
--	--	1231.8	4.20 S	04/26/1974	--	O	G	SILTY CS GL; WL RECORDER 1974
--	14	1275	27.00 R	05/ /1962	6.5 B	H	--	GPM ENTER: 1 AT 75, 5.5 AT 85
--	--	1275	36.00 R	1967	13 R	H	--	--
--	--	1242.9	27.30 S	04/06/1974	10 R	H	--	HARD WATER
--	--	1232.7	20.07 S	04/06/1974	30 B	H	--	LITTLE DD AT 30 GPM; GL 0-6 FT
--	--	1217.7	8.08 S	04/06/1974	--	H	--	SILTY GRVL 0-8 FT NEARBY
37	--	1237.7	25.76 S	05/08/1974	--	O	G	TILL 12-23, SILTY GL 23-37 FT
--	--	1237.7	dry S	05/08/1974	--	O	G	2ND of 2 WELLS IN 6-IN HOLE
				CAROLINE				
68	--	1315	23.43 S	07/10/1980	50 B	H	M	SILTY GL 0-68, SILTY >70 FT
--	--	1280	25.00 R	1972	--	H	--	CL OVER GL; ALSO 22-FT POINT
--	--	1290	--	--	--	H	--	LOW YIELD;ALSO 20-FT DUG WELL
--	--	1246	--	--	--	H	--	
--	--	1275	--	--	--	H	--	GOOD YIELD
--	--	1275	5.00 R	10/ /1975	--	S	--	WATER MODERATELY HARD
12	--	1260	8.50 E	10/10/1980	--	Z	G	USGS TH; CL 0-12, SI SDGL -68
35	--	1280	10.00 R	1951	--	H	--	CL 0-35,GL 38; 18 FT POINT TOO
--	--	1300	--	--	6 R	H	--	WATER AT 20 FT IN GL, BYPASSED
--	--	1280	--	--	--	H	--	WATER MODERATELY HARD, IRON
--	--	1305	--	--	--	H	--	WATER SOFT
--	--	1306	--	--	10 R	H	--	WATER SOFT
33	--	1282	--	--	10 R	H	--	DEEPENED FROM 86 FT FORMERLY
8	--	1282	--	--	--	H	--	GL 0-6, HP 6-8 FT
--	--	1308	--	--	--	H	--	GOOD YIELD
--	--	1283	20.00 R	1972	--	H,S	--	GOOD SUPPLY; HARDNESS 9 GR
				WILLSEYVILLE CREEK				
90	--	965	12.00 R	06/ /1965	10 B	H,S	M	GL 0-25; QS -90; GL,HP -115
--	--	1010	63.60 S	08/05/1980	--	S	--	HARDNESS 10 GR
85?	--	1010	--	--	--	H	--	PUMPED 4 DAYS TO CLEAR
80?	--	1015	--	--	--	H	--	ALSO FEEDS 40 LAWN SPRINKLERS
--	--	1005	--	--	--	H	--	
--	--	970	--	--	5 R	H	--	HARD WATER
--	--	970	--	--	--	H	--	HARDNESS 10GR; GL 0-5, CL 5-?
16	--	990	15.00 E	10/07/1980	--	Z	G	USGS TH; GL 16-53, FSD,CL -77
15	15	1080	--	--	6 R	H	--	SOFT WATER
0	--	993	9.00 E	10/09/1980	--	Z	G	USGS TH; PEBBLY SI,CL 33-73

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin-ish	Depth cased	Casing diam-eter (in.)	Principal aquifer	Aquifer lithology
PONY HOLLOW (fig. 29, p. 80-81)							
421749076412101	SCHAAD, DON	40.00	O	--	6	112GRVL	--
421805076405401	NY DEPT TRANSP	41.00	--	--	--	--	GRVL
421808076405101	LEISTER, ROBERT	22.00	T	20	2	110QRNR	--
421811076404601	NY DEPT TRANSP	46.00	--	--	--	--	GRVL
421817076403801	NY DEPT TRANSP	38.00	--	--	--	--	GRVL
421834076402101	CEKSLOV FARMERS	41.00	O	41	6	110QRNR	--
421841076401601	HOLUB, WILLIAM	37.50	O	45	6	112GRVL	--
421849076400601	GOTIER, BENJAMIN	120.00	--	--	6	--	--
421854076395901	HOLUB, WILLIAM	58.00	O	58	6	110QRNR	GRVL
421906076395001	NY DEPT TRANSP	40.00	--	--	--	--	--
421924076393001	NY DEPT TRANSP	37.00	--	--	--	--	GRVL
421925076392901	US GEOL SURVEY	24.00	O	24	6	112OTSH	GRVL,SILTY
421927076392601	HOLUB, FRANK	59.00	O	60	6	110QRNR	--
421936076385601	US GEOL SURVEY	41.20	S	31	1.25	112GRVL	GRVL,PEBBLY
421944076384301	MAZOUREK, BOB	85.00	O	85	6	112GRVL	--
421944076384501	MAZOUREK, BOB	160.00	X	80	6	341SONY	--
421944076384502	MAZOUREK, BOB	70.00	--	--	--	112GRVL	--
421948076381601	MAZOUREK, RICHARD	85.00	O	85	6	112GRVL	--
ALPINE (fig. 29, p. 80-81)							
421705076422501	SIMPSON, CHARLES	45.00	O	45	6	112SDGV	--
421731076420501	HUGHSON, FRED	82.00	X	75	6	341SONY	SHLE,SILTY
421734076425801	VAN ALSTINE, GERALD	50.00	--	--	6	112SRFD	--
421734076432301	PATY, ANTON	32.00	O	32	6	110QRNR	--
421810076430801	GROVER, CHET	24.00	T	22	1.25	112SDGV	SDGL,CLEAN
421825076431601	DUDGON, FRANK	18.00	O	18	6	110QRNR	--
421836076431801	THORPE, KATHRYN	24.00	O	24	6	112ICNC	SAND, GRVL
421836076432201	SHAY, MARIE	16.00	T	14	1.25	110QRNR	--
421836076432701	ELDRIDGE, KEN	21.00	O	21	6	110QRNR	SAND, PEBBLY
421837076432401	FARARY, W	27.00	O	27	6	110QRNR	SAND
421839076432301	OLIN, FLOYD	30.00	--	20?	6	341SONY	--
421840076432301	SMITH, ROYCE	30.00	X	24	6	341SONY	SHLE,BLACK SAND
421845076432601	GROVER, JOHN	149.00	X	40	6	341SONY	--
421847076435001	VAN ZILE, ALICE	65.00	X	--	6	341SONY	--
421848076435101	VAN ZILE, ALICE	125.00	X	--	6	341SONY	--
421850076431501	MORGAN, RONALD	20.00	W	--	36	110QRNR	--
421850076432501	BAILEY, ANNE	20.00	O	20	6	112SDGV	--
BEAVER DAMS (fig. 30, p. 86)							
421532076573601	BEAVER VALLEY SUBDV	55.00	G	45	12	110QRNR	GRVL, SAND
421712076573701	DREW, DOUGLAS	21.00	T	18	2	110QRNR	--
421722076572101	WATKINS, JOAN	32.00	O	32	6	110QRNR	--
421723076573501	LAKE, EARL	25.00	T	23	2	112GRVL	GRVL,SANDY
421730076573601	OVERHISER, ELMER	40.00	T	38	2	112GRVL	--

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				PONY HOLLOW				
--	--	1135	18.58 S	08/09/1980	--	H	--	DEPTH MEAS 26 FT, OBSTRUCTION?
--	--	1147	3.00 R	04/09/1956	--	T	D	GL, SOME SD, SI 0-41 FT
--	--	1152	10.00 R	05/ /1959	--	H	--	WELL IN CELLAR 8 FT BELOW LSD
--	--	1164	5.00 R	03/08/1957	--	T	D	GL, SOME SD, SI, TR CL 0-46
--	--	1157	2.00 R	03/22/1957	--	T	D	GL, SOME SD, SI, TR CL 0-38
--	--	1169	4.00 R	05/31/1960	50	H	--	WELL SERVES LODGE HALL
--	--	1175	5.24 S	04/21/1981	--	H	--	WATER MED HARD, GRVL 0-45 FT
--	--	1189	14.76 S	04/21/1981	--	H	--	FORMER SCHOOLHOUSE
--	--	1200	--	--	18	H	--	
--	--	1195	1.70 R	04/11/1956	--	T	D	GL, SOME SD, SI 12-38 FT
--	--	1221	2.50 R	04/17/1956	--	T	D	GL, SOME SD, SI 22-37 FT
--	--	1223	9.00 S	05/02/1968	15 V	O	G	GL, SILTY 0-24; WL 15 AUG 68
--	--	1225	24.62 S	05/02/1968	--	H	--	GL, THEN QS; WL 40.2 OCT 68
20	--	1222	29.47 S	05/05/1981	--	O	G	GL, SILTY EXCEPT 20-22, 35-42
--	--	1248	40.00 R	--	40 R	H	--	
80	--	1243	60.00 R	1979	5 R	H	--	TILL? 0-80,SH 80-120;SULFUR
--	--	1243	40.00 R	--	30 R	--	--	GRVL LAYERS; DRY IN AUG.
--	--	1244	40.00 R	--	--	H	--	GRVL 0-85; HIGH YIELD
				ALPINE				
--	--	1115	7.00 E	--	--	H	--	GRVL W/CL LAYERS 0-45 FT
--	--	1175	57.00 R	06/06/1960	20 R	H	--	HARDNESS 176, SILICA 10 MG/L
--	--	1115	--	--	--	C	--	MOTEL; WATER HARD
--	--	1153	7.77 S	07/ /1967	10 R	H	--	
--	--	1145	--	--	--	M	--	HP 0-17, SDGL 17-24 FT
--	--	1145	--	--	--	H	--	WATER STANDS IN WELL PIT
--	--	1150	--	--	12 R	H	D	GL CL 0-18, SDGL 18-24 FT
--	--	1155	--	--	--	H	--	WATER FILLS WELL PIT IN APRIL
--	--	1159	15.52 S	09/30/1965	7 R	H	G	TILL 0-2, CUTTINGS = SD,SI,CL
22	--	1160	17.00 R	--	12 B	H	D	SI, CL 0-22, GRVL 22-27 FT
--	--	1157	14.00 R	summer	12 R	H	M	CL 0-15, GL 15-18 IN DITCH
24	--	1155	10.23 S	08/08/1980	12 R	H	M	CL 0-12,GRVL 12-24,SH 24-30
--	--	1158	15.00 R	1955	--	H	M	PEBBLY CL 0-12, GRVL 12+ FT
--	--	1290	--	--	--	H	--	
--	--	1290	--	--	8 R	H	--	
--	--	1160	10.00 R	--	--	H	--	
--	--	1155	5.12 S	08/13/1980	8 R	H	M	CL OVER DRAB GRVL;SOFT WATER
				BEAVER DAMS				
38	--	1185	8.00 O	07/24/1953	203 O	P	D	CL 0-13, GR CL SD 13-38 FT
17	--	1255	--	--	17 R	H	--	WATER HARD, IRON
--	--	1265	--	--	--	H	--	VERY HARD WATER
20	--	1260	5.00 R	--	--	H	M	SDGL 0-25; SOFT WATER
--	--	1266	--	--	13 R	H	--	LAYERS GRVL,CL; WATER AT 11

Table 7.--Records of wells and test holes (Continued).

Site identification	Owner	Depth of well (ft)	Fin-ish	Depth cased	Casing diam-eter (in.)	Principal aquifer	Aquifer lithology
			BEAVER DAMS (Continued)				
421735076573401	GARDINER, GERALD	40.00	O	40	6	112SRFD	--
421737076573601	WHITE, FRED	47.00	O	47	6	112SRFD	--
421738076571601	KEENEY, JAMES	60.00	O	60	6	112SRFD	--
421744076573601	BLANK, CHARLES	60.00	P	57	2	112GRVL	GRVL
421746076571901	BONHAM, KATHLEEN	59.00	T	56	4?	110QRNR	--
421753076571301	MATTISON, DOROTHY	52.00	O	52	6	110QRNR	--
421754076573201	GILES, ERNEST	65.00	O	65	6	112SRFD	--
421758076570901	CAIN, DONALD	63.00	X	23?	6	341JVWF	SHLE ?
421801076570801	DILIBERTO, FRANK	65.00	O	65	6	110QRNR	--
421812076570201	DERSHAM	72.00	O	72	6	110QRNR	--
421830076572701	BLODGETT, GERALD	45.00	O	45	6	112GRVL	GRVL
421834076572301	BUTLER, RALPH B	36.00	O	36	6	112SRFD	--
421835076565201	LA FEVER, MAUREEN	55.00	O	55	6	112GRVL	GRVL
421835076570502	HOKE, HARRY	16.80	W	--	36	110QRNR	--
421835076570501	HOKE, HARRY	22.00	T	20	2	110QRNR	--
421837076565301	LA FEVER, MAUREEN	56.00	O	72	3.5	--	--
421837076572501	COOPER, R	26.00	O	26	6	110QRNR	SAND
			BATH (fig. 31, p. 88)				
421935077183701	NY DEPT TRANSP	138.00	--	--	--	--	GRVL, SANDY
421950077190001	VILLAGE OF BATH	117.00	--	--	5	--	--
421954077192001	VILLAGE OF BATH	81.00	G	71	18	112SDGV	SAND,POORLY SORTED
421958077191001	VILLAGE OF BATH	196.00	--	--	24	BEDROCK	--
422002077191101	TETORS DAIRY	160.00	O	160	6	110QRNR	GRVL
422026077195701	VILLAGE OF BATH	28.00	O	28	210	110QRNR	GRVL
422026077195702	VILLAGE OF BATH	464.00	X	120	8	BEDROCK	--
422037077183001	VILLAGE OF BATH	75.00	G	65	12	110QRNR	SAND,POORLY SORTED
422104077183001	BONADY BROS FOOD	70.00	O	70	8	110QRNR	SAND,COARSE GRAINED
422207077173901	--	45.00	O	45	6	110QRNR	SAND AND GRVL
422211077170301	NY DEPT TRANSP	81.00	--	--	--	110QRNR	SAND,COARSE GRAINED
4222190771709	NY FISH HATCHERY	65.00	O	65	8		COARSE SAND
4222210771707	NY FISH HATCHERY	38.00	S	28	8		GRVL, CS SAND
4222210771716	NY FISH HATCHERY	300.00	--	--	8		SAND, F GRVL
422223077170601	NY FISH HATCHERY	40.00	O	40	4	110QRNR	SAND
422229077164601	DAVENPORT HOSPITAL	155.00	O	--	--	110QRNR	SAND,CLAYEY
4222240771705	NY FISH HATCHERY	35.50	S	26	8		SAND, GRVL
4222280771702	NY FISH HATCHERY	44.00	S	38	8		GRVL, CS SAND
			NORTH COHOCTON (fig. 32, p. 90)				
423302077283101	BOGGSGRADER CORP	91.60	--	--	6	110QRNR	SAND,GRVL
423310077284601	BABBIN & HARMON	21.00	P	--	1.25	110QRNR	SAND
423314077290401	LANDINO, LES	33.00	O	--	6	110QRNR	GRVL
423322077302201	BRUNSWICK, HOWARD	14.55	T	--	1.25	110QRNR	SAND
423323077284801	NY DEPT TRANSP	36.00	--	--	--	--	--

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				BEAVER DAMS (Continued)				
--	--	1265	20.00 R	--	--	H	--	WATER AT 20 FT; MEDIUM HARD
--	--	1269	26.00 R	04/ /1979	15 B	H	--	WATER AT 27 FT; HARD WATER
--	--	1275	32.25 S	09/17/1980	--	P	--	TRAILER PARK; 2ND WELL 62 DEEP
--	--	1272	--	--	--	H	--	HIGH YIELD; SOFT WATER
--	--	1291	--	--	--	H	--	WATER AT 30 AND 55 FT
--	--	1300	42.82 S	09/17/1980	--	U	--	WELL IN USE REPT 82 FT DEEP
--	--	1282	--	--	--	H	--	HARD WATER
	--	1312	25.00 R	01/ /1978	18 B	H	--	GRVL 0-23,SHLE(?)23-63 FT
--	--	1312	--	--	--	H	--	WATER MEDIUM HARD
--	--	1326	--	--	--	H	--	HARD WATER
--	--	1321	--	--	--	H	--	GRVL 0-45 FT
--	--	1320	34.67 S	09/23/1980	8 B	H	--	WATER AT 25 FT
--	--	1290	30.00 R	--	15	H	--	GL 0-55, WATER AT 30,MED HARD
--	--	1276	11.80 S	09/23/1980	--	U	--	--
--	--	1276	9.00 R	1978	--	H	--	WELL IN CELLAR
--	--	1310	41.20 S	09/23/1980	--	U	--	OLD WINDMILL; FILLED IN TO 56
--	--	1330	16.00 R	--	--	H	--	
				BATH				
18	--	1100	--	--	--	T	G	
--	--	1095	--	--	--	U	D	
51	--	1100	8.00 R	12/ /1952	759 O	P	D	TEMP 10.8°C OCT 1965
--	193	1100	--	--	--	U	D	
150	175	1100	5.00 R	12/ /1945	200	U	D	MOSTLY QS, CLAY 20-150 FT
0	--	1105	8.00 R	12/ /1945	150	U	--	
--	120	1105	20.00 R	--	55	U	D	
53	--	1116	29.00 R	03/ /1961	152 O	U	D	
58	--	1140	--	--	74	A	D	
--	--	1090	26.00 S	09/ /1966	70 B	H	--	
30	--	1059.0	--	--	--	T	D	
5	--	1018	--	--	--	Z	D	
11	--	1015	0	08/ /1981	150	T	D	DD23FT;DISS.SOLIDS 344 MG/L
0	--	1050	--	--	--	Z	D	CLAY,FINE SAND 94-300 FT
--	--	1002	FLOWS S	08/ /1967	400	S	--	
--	--	1100	--	--	--	U	D	SMALL YIELD;DRY 0-400 NEARBY
--	--	1010	0.53	08/ 6/1975	200	T	--	DISSOLVED SOLIDS 306 MG/L
8	--	1010	2.0	08/25/1981	100	T	D	DD20FT;DISS.SOLIDS 257 MG/L
				NORTH COHOCTON				
--	--	1320	11.77 S	06/13/1949	75	U	--	0-92? GRAVELLY CLAY, T7.8°C
--	--	1320	17.00 R	--	10	C	--	REPLACED BY WELL 12 FT DEEP
23	--	1330	23.00 R	--	--	H	--	CS GRVL 3-33 FT
--	--	1330	12.06 S	10/ 2/1966	--	U	--	2 NEARBY WELLS 30 FT DEEP
--	--	1314	--	--	--	T	G	PEAT,MARL 0-9,GRVL 9-23 FT

Site identification	Owner	Depth of well (ft)	Fin- ish	Depth cased	Casing diam- eter (in.)	Principal aquifer	Aquifer lithology
		NORTH COHOCTON (Continued)					
423326077284701	NY DEPT TRANSP	116.00	--	--	--	--	--
423328077284601	NY DEPT TRANSP	35.00	--	--	--	NONE	--
423330077274401	MILLER, GEORGE	101.70	O	110	6		SAND
423330077301801	BRUNSWICK, HOWARD	49.40	O	--	6	110QRNR	SAND
423335077280801	TOWN OF COHOCTON	72.00	O	72	8	110QRNR	GRVL
423338077274601	TOWN OF COHOCTON	265.00	O	255	6	110QRNR	SAND,SILTY
423340077281801	FOX, HERMAN C	41.40	O	--	6	110QRNR	SAND
423341077284801	JOHNSON, BETTY	9.65	T	--	1	110QRNR	SAND
423343077283101	HAUS, C A	18.30	W	0	36	110QRNR	SAND
423404077291101	LANDERS, E	36.00	O	36	6	110QRNR	GRVL,MED GRAINED
423404077300701	SEMANS, STEVE	115.00	O	115	6	--	GRVL
423408077291101	POLMANTEER, D	50.00	O	50	6	110QRNR	SAND,COARSE GRAINED
423414077272901	MIDDLETON	90.00	O	90	6	110QRNR	GRVL,FINE GRAINED
423416077272101	FLEISCHMAN, PEARL	142.00	O	142	6	110QRNR	SAND,COARSE GRAINED
423440077285401	SAXTON, DONALD	46.00	O	46	6	--	--
		WAYLAND (fig. 33, p. 92)					
423245077322801	STEPHENS	43.00	X	40	6	--	BEDROCK --
423313077352401	GUNLOCKE CHAIR CO	88.00	X	40	5	341DVNNU	--
423316077352001	GUNLOCKE CHAIR CO	45.00	G	25	18	110QRNR	SAND
423342077351701	WAYLAND VILLAGE	75.00	--	62	10	110QRNR	SAND
423344077354801	WAYLAND VILLAGE	41.00	S	36	6	110QRNR	SAND,POORLY SORTED
423345077355201	WAYLAND VILLAGE	42.00	G	36	8	110QRNR	SAND,GRVL,WELL SORTED
423345077355202	WAYLAND VILLAGE	44.60	G	35	12	110QRNR	SAND,GRVL,WELL SORTED
423346077345701	WAYLAND VILLAGE	34.00	G	29	6	110QRNR	SAND,GRVL
423349077354801	WAYLAND VILLAGE	65.00	O	58	8	110QRNR	SAND,GRVL
423353077345801	WAYLAND VILLAGE	54.00	--	46	10	110QRNR	SAND,GRVL
423357077345801	WAYLAND VILLAGE	39.00	G	34	6	110QRNR	SAND,COARSE GRAINED
423417077354001	WAYLAND VILLAGE	85.00	--	80	8	110QRNR	SAND,GRVL
423417077354002	WAYLAND VILLAGE	58.70	G	49	10	110QRNR	SAND,GRVL
423421077334401	INSCHO, GLEN	90.00	O	90	6	NONE	--
423423077350001	WAYLAND VILLAGE	62.00	X	51	8	BEDROCK	--
423434077340801	BEECHER, WAYNE	80.00	X	62	6	110QRNR	--
		BURNS (fig. 34, p. 94-95)					
422317077411001	BRIDGE, WILLIAM	36.00	O	36	100	110QRNR	SAND,COARSE GRAINED
4223290774147	NY DEPT TRANSP	51.00	--	--	--	--	--
422335077420101	ARKPORT DAIRIES	30.00	P	--	96	112SDGV	GRVL,SANDY
422337077420301	ARKPORT DAIRIES	35.00	O	--	6	110QRNR	GRVL,POORLY SORTED
4223490774154	NY DEPT TRANSP	60.00	--	--	--	--	--
4223530774154	NY DEPT TRANSP	78.00	--	--	--	--	--
4224070774157	NY DEPT TRANSP	37.00	--	--	--	--	--
422419077425001	SCHULTHEIS POTATO CO	40.00	O	40	--	112GRVL	GRVL
422537077422901	NUE, MILTON	135.00	O	134	6	110QRNR	SAND,COARSE GRAINED
422540077422801	BLOOM, EARL	124.00	X	86	--	341JVWF	--
422541077422801	BLOOM, EARL	39.80	O	40	--	112SAND	SAND,PROBABLY
422547077423001	PIERCE, DAVID	65.10	O	65	6	110QRNR	SAND, FINE GRAINED

Table 7.--Records of wells and test holes (Continued).

Depth to aquifer (ft)	Depth to bedrock (ft)	Altitude (ft below land surface)	Water level (ft)	Date of measurement	Yield (gal/min)	Well use	Type of log available	Remarks
				NORTH COHOCTON (Continued)				
--	--	1311	--	--	--	T	G	PEAT,MARL 0-17,GRVL 17-28 FT
--	--	1311	--	--	--	T	G	9-35 FT SI, TRACES SD, STONE
110	--	--	50.41 S	09/19/1985	6	U	--	CL 4-108, YIELD DECLINED 1982
--	--	1350	20.00 S	07/13/1965	--	S	--	--
70	--	1340	36.00 R	07/21/1949	110	P	D	CL EXCEPT GRVL AT 45,55,70 FT
247	--	1370	115.00 R	1948	15 E	T	D	MOSTLY CL,QS; SLOW RECOVERY
--	--	1342	39.52 S	08/ 3/1966	--	U	--	--
--	--	1320	7.52 S	08/ 3/1966	--	U	--	--
--	--	1330	17.39 S	08/ 3/1966	--	U	--	--
18	--	1360	30.00 R	02/ /1949	5	H	M	CL & GL 0-12, QS 12-18 FT
--	--	1435	61.00 R	11/ /1980	--	H	--	--
--	--	1360	36.00 R	07/ /1960	18 B	H	--	3 FT CL ABOVE CS SD AT BOTTOM
90	--	1390	60.00 R	1947	15	U	M	CL & GRVL 0-90 FT
100	--	1390	80.00 R	1956	20 E	S	M	SANDY LOAM, CLAY 0-100 FT
45	--	1370	--	--	50 B	H	--	CL21-45 FT;FORMER WELL 20 FT
				WAYLAND				
--	--	1360	4.00 R	09/ /1965	27	H	--	WATER FROM GRVL AT 34 FT
--	--	1365	FLOWS R	1944	300	N	--	WL 7 FT JUNE 1946
20	--	1360	4.00 R	12/12/1961	1506 O	F	D	CL, CLAYEY GRVL 0-20 FT
22	--	1365	--	--	--	T	D	SD GL 0-49;VF SD,CLAY 49-75
36	--	1368	5.00 R	01/17/1956	150	T	D	GL SD CL 0-43; CL 43-55 FT
17	--	1375	8.00 R	10/17/1947	100	T	D	GL CL 0-17,GL 17-45,CL 45-85
17	--	1375	6.20 R	05/30/1956	703 O	P	--	DD 15 FT AFTER 52 HR
14	--	1365	9.20 R	12/16/1954	35	T	D	GL CL 0-14,F SD 36-62,CL 62-68
27	--	1375	11.00 R	01/ 6/1956	--	T	D	GL SD CL 0-27, 37-50;CL 50-65
32	--	1370	16.00 R	12/ /1954	--	T	D	GL CL 0-32,F SD 38-44,CL 44-54
28	--	1370	7.40 R	01/27/1955	60	T	D	GL CL 0-28,SD SI CL 39-46 FT
26	--	1380	25.00 R	--	--	T	D	GL CL 0-26,GL 26-62,CL 62-85
26	--	1380	14.40 R	07/31/1947	780 O	P	--	DD ABOUT 24 FT AFTER 58 HR
--	--	1380	--	--	--	Z	D	SI GL 0-18,SD 18-28,CL 28-90
50	50	1420	28.00 R	12/12/1955	--	T	D	CL GL 0-50 EXCEPT CL 17-28
--	63	1485	--	--	--	S	--	ALL WATER ABOVE TOP OF ROCK
				BURNS				
25	--	1200	24.80 S	10/04/1965	560	I	M	COARSE SDGL 0-36 FT
--	--	1181	--	--	--	T	G	SDGL,SILTY 0-42, F SD 42-51FT
18	--	1190	17.60 S	08/25/1965	--	N	M	SDGL 5-30; HARDNESS 240 MG/L
0	--	1190	0.50 R	1944	--	U	M	GL 0-35, QS 35-150 FT
--	--	1185	--	--	--	T	G	SI,SD,ORGANIC 0-38;SDGL 38-60
--	--	1186	--	--	--	T	G	SI 0-15; SDGL -36; SI,FSD -78
--	--	1184	--	--	--	T	G	SI 0-8,13-24;SI,GL 8-13,24-37
--	--	1205	27.00 R	--	16	C	--	GRVL 0-40
134	--	1210	22.00 R	03/ /1946	30 B	H	D	GL 0-25; CL,QS 25-134; GL 135
86	--	1210	--	--	--	C,H	--	QS; REPLACED 40FT WELL 1973
--	--	1210	33.23 S	03/09/1974	--	U	--	1800'W DITCH DEEPENED 5' 1973
64	--	1210	36.00 S	08/25/1965	10 B	H	D	SDGL 0-30; SI,F SD,CL 30-65

☆ U.S. GOVERNMENT PRINTING OFFICE: 1988—201 - 979 / 60002